Power Engineering

DR. ABETTI'S OWN STORY ON PROJECT EHV

The upper half of the rotor housing of a Ljungstrom Air Preheater is lowered into position at the Allen Plant of Duke Power Company, Belmont, N.C.

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*Patent applied for

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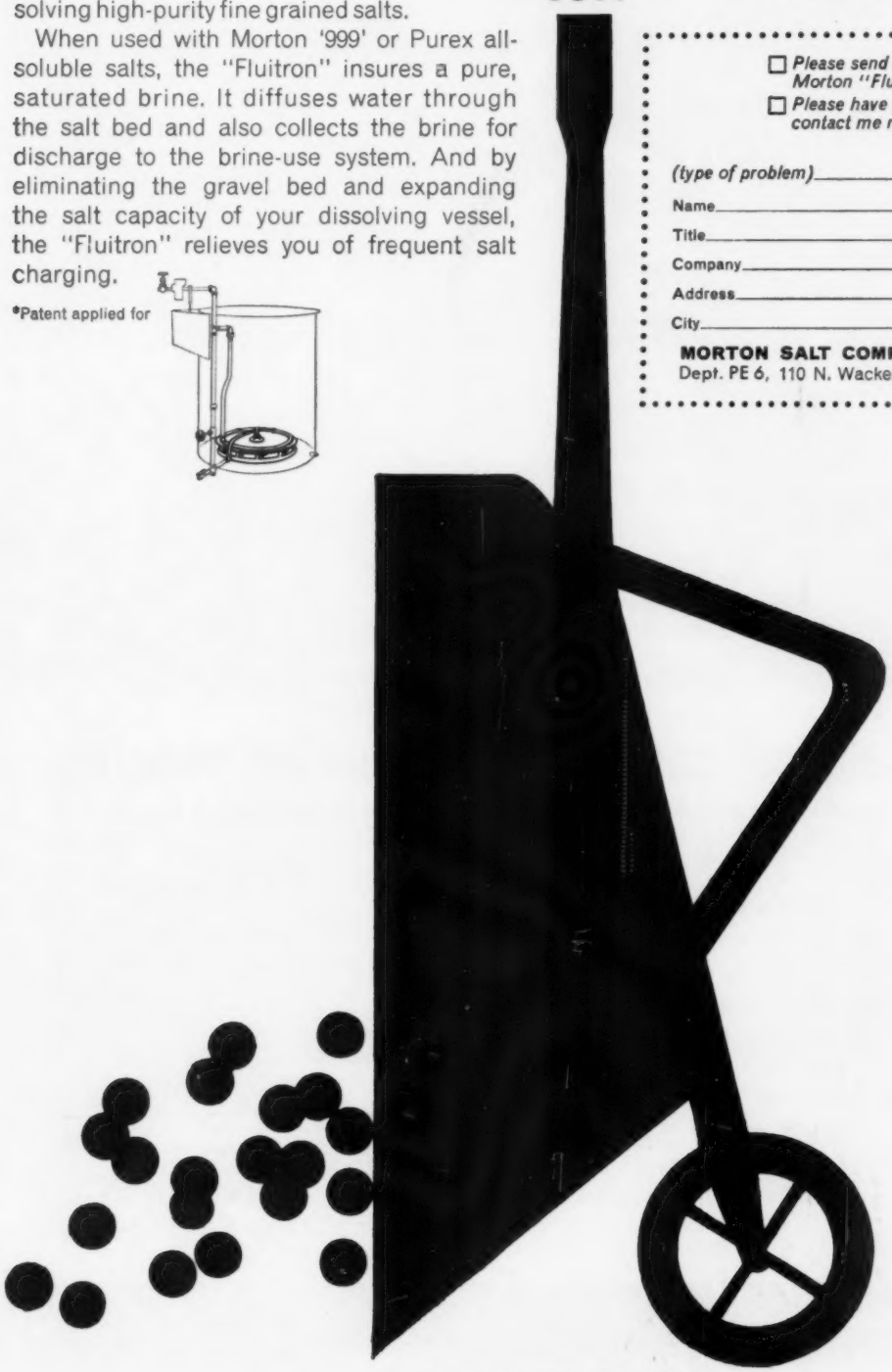

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Comment

In this issue we give you two bonus items: A NEW FRONT COVER and DR. PIER ABETTI's OWN STORY on PROJECT EHV —written exclusively for POWER ENGINEERING readers.

As you see, our traditional front-cover index has moved to this page, and will appear in this position each month in the future. We intend to be as dynamic as the power field itself, and hope all our readers will like this new look we are presenting.

Bob McCaw

EDITOR

Power Engineering

Complete editorial index

ON THE COVER

A graphic tribute to Project EHV is this lineman, high on one of the all-aluminum structures at North Substation. Tower was furnished by Aluminum Co. of America. (Photo by courtesy of Alcoa)

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around the power circuit

Looking down chimney of thermoelectric generator shows six thermocouples lined up directly over the kerosene flame in new 3M "Aztec"

COMMONWEALTH EDISON has ordered two turbine-generators from Westinghouse, each of which will have a net generating capability of 560,000 kw. Largest ever ordered by Commonwealth, the first of the two new units has been ordered for service at the utility's Joliet station early in 1965; the second for service in 1965 or 1966 at a location not yet determined. The order amounted to $22,050,000, or $19.69 per kilowatt.

PORTABLE thermoelectric generator capable of powering a transistor radio from the heat of a kerosene flame has been developed by Minnesota Mining and Manufacturing Co. Designed for use as a simple emergency power source, the generator could also be used in the event of power failures caused by tornadoes, ice storms or other natural disasters, and in remote areas where electrical power is not available or battery supplies are limited.

One pint of kerosene or fuel oil reportedly will operate the generator continuously for 24 hours. In the absence of a lamp base or a supply of kerosene, the generator can be heated sufficiently for radio operation by a pair of candles held beneath the generator chimney.

Heat from the flame of an ordinary kerosene lamp wick acts on six hermetically sealed thermocouples in the unit to produce low-voltage, high-current electrical power. There are no moving parts in the generator, and the only maintenance required is in trimming the wick.

CASE of the Federal Government against the City of St. Joseph, Mo., for pollution of the Missouri River has been broken by the passage by the city of a $5,955,000 bond issue to be used for construction of a municipal wastes treatment plant. The residents of St. Joseph had twice voted down bond issues proposed for this purpose.

IDENTICAL PRICING has resulted in the rejection of bids on 14 out of 16 schedules for procurement involving $1\frac{1}{4}$ million worth of transmission line materials required by the Bureau of Reclamation. Commissioner of Reclamation Floyd E. Dominy said the bids were received from a total of 19 companies responding to each of two invitations. Although comparing favorably with the engineer's estimates, the bids were rejected because prices bid on the individual items were identical.

PACIFIC GAS & ELECTRIC plans to double the size of its Contra Costa Power Plant in eastern Contra Costa County at an investment of $73 million. The project will add 660,000 kw to the plant in two new units, raising the total generating capacity to 1,270,000 kw.

PG&E also plans to double the size of The Geysers Geothermal Plant in northeastern Sonoma County. The plant, which generates electricity with natural steam brought from within the earth, began operation last summer. It is the first of its kind in America. PG&E will add a 12,500-kw generating unit to the one of that size already in service at The Geysers.

THE INTERCONNECTION and power pooling process has been accelerating all over the United States. Now comes news of plans for a 4000-mile network of extra-high-voltage electric transmission lines in the Southwest. This new transmission grid will make available interconnections of greater capacities than ever before for electric power systems in an eight-state area composed of Arkansas, Kansas, Louisiana, Mississippi, Missouri, Nebraska, Oklahoma and Texas.

Estimated to cost more than $300 million, the grid will be designed for initial operation of 345,000 v, with provision for future enlargement to 500,000 v when needed. The 345,000-v line will be six times greater in electric power capacity than any other transmission line now operating in the Southwest.

Plans are also afoot to interconnect the electric transmission systems of Arizona Public Service and Public Service of New Mexico. Interconnection will be accomplished through construction of a 230,000-v line by Public Service of New Mexico from Ambrosia Lake to a point near Arizona Public Service's new Four Corners Power Plant. This plant is now under construction south of Farmington, New Mexico, and is expected to be completed in 1963.

Continued on page 6

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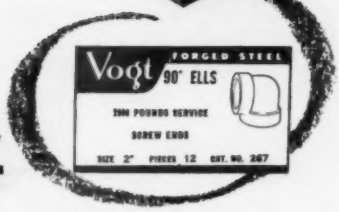

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PROTOTYPE of a biochemical fuel cell, a potentially important new energy source for commercial or industrial purposes, under development by scientists of the Geological Survey, Department of the Interior, has been demonstrated before members of the National Academy of Sciences. Dr. Frederick D. Sisler, Survey microbiologist, said the idea of harnessing bacteria to produce electrical energy directly from the decomposition of organic matter created through photosynthesis and biological processes in the sea, resulted from routine geochemical studies of marine sulfate-reducing bacteria.

Dr. Sisler's prototype unit is composed of two sections containing inert electrodes—an anode section and a cathode section — separated by an ion-diffusion bridge. A mixture of sea water containing organic matter as fuel and bacterial cells (or enzymes) as a catalyst is placed in the anode section. The cathode section contains sea water and oxygen. Essentially the energy released comes from bacteria "burning" the organic matter, but the cell design is such that the energy is released as electricity instead of heat.

A 12,000-KW Econo-Pac gas turbine power plant—the first ever ordered —has been purchased by the City of Houma, La., from Westinghouse. The new unit was sold on a "turnkey" basis, which includes installation. The complete package will be semi-portable, with prefabricated construction, and will be used primarily for low-use-factor peaking service of about 1000 hours per year.

OTTER TAIL POWER CO., Fergus Falls, Minn., will construct a 66,000-kw North Dakota lignite coal-fired steam generating unit at one of two locations in the Minnesota portion of its service area. The new unit, to cost nearly $12 million, is scheduled to be in operation on the Otter Tail system in late 1964.

MIDWEST PIPING has received a contract to fabricate and erect all piping for San Diego Gas & Electric Co.'s South Bay Station, Unit No. 2, at Chula Vista, Calif. Completion is scheduled for July 1962. The contract totals well over $1 million.

The new unit will incorporate a 136,000-kw turbine-generator and a 980,000-lb/hr boiler, with operating conditions of 1005 F at 2000 psig. Engineers on the project are Pioneer Service & Engineering Co.

RATIFIED by the U.S. Senate, the U.S.-Canadian treaty for cooperative development of the water resources of the Columbia River now awaits acceptance by the Province of British Columbia and ratification by Canada. Under the agreement, Canada will provide 15.5 million acre-ft of storage behind three dams in British Columbia and will regulate the flow for best power utilization downstream in the U.S. and for control of its floods. The U.S. will construct the Libby Project on the Kootenai River in Montana.

ENGLISH ELECTRIC CORP. has been incorporated in the State of Delaware as a wholly-owned subsidiary of The English Electric Co. Ltd. of London, England. The new corporation consolidates the U.S. activities of the English Electric Export and Trading Co., Marconi's Wireless Telegraph Co., Marconi Instruments and the English Electric Valve Co., all of which have been represented here for 10 years or more. President of the corporation is E. S. Dean.

LEEDS & NORTHRUP CO. has received a second order from Public Service Electric and Gas Co. of New Jersey for an LN 3000 computer system. It will be used at Mercer Generating Station to accomplish complex boiler-turbine unit performance calculations and display operating guides to aid in optimizing the performance of the two 320-Mw generating units at this new plant.

TRANSMISSION AND DISTRIBUTION Committee of Edison Electric Institute held its 85th meeting in Cincinnati on May 17 - 19. This session was most interesting, and the attendance was high, including almost 200 members and guests. Highlighting the conference were discussions on bare-hand hot-line work, aluminum towers, service reliability and underground cable performance. A detailed report on this meeting will appear in the July issue.

LUMMUS CO. of New York City has been selected for the architect-engineer assignment for the east coast saline water conversion pilot plant which is to be erected at Wrightsville Beach, N.C., by the U.S. Office of Saline Water. The contract is a cost-reimbursable fixed-fee contract not to exceed $99,800. The Wrightsville Beach plant will demonstrate a freezing process and will be designed to convert sea water to fresh water at an anticipated rate of 250,000 gpd.

ELECTRIC POWER INDUSTRY is expected to reach new highs in output and generating capability in 1961 despite the general business recession, according to the 29th semi-annual electric power survey of the Edison Electric Institute.

Output for the total electric utility industry in the United States (excluding Alaska and Hawaii) is expected to reach 819 billion kwh by the end of 1961—an increase of 7 per cent over the 1960 output of 765 billion kilowatt-hours. This will climb to more than one trillion kilowatt-hours by the end of 1964, the study indicates.

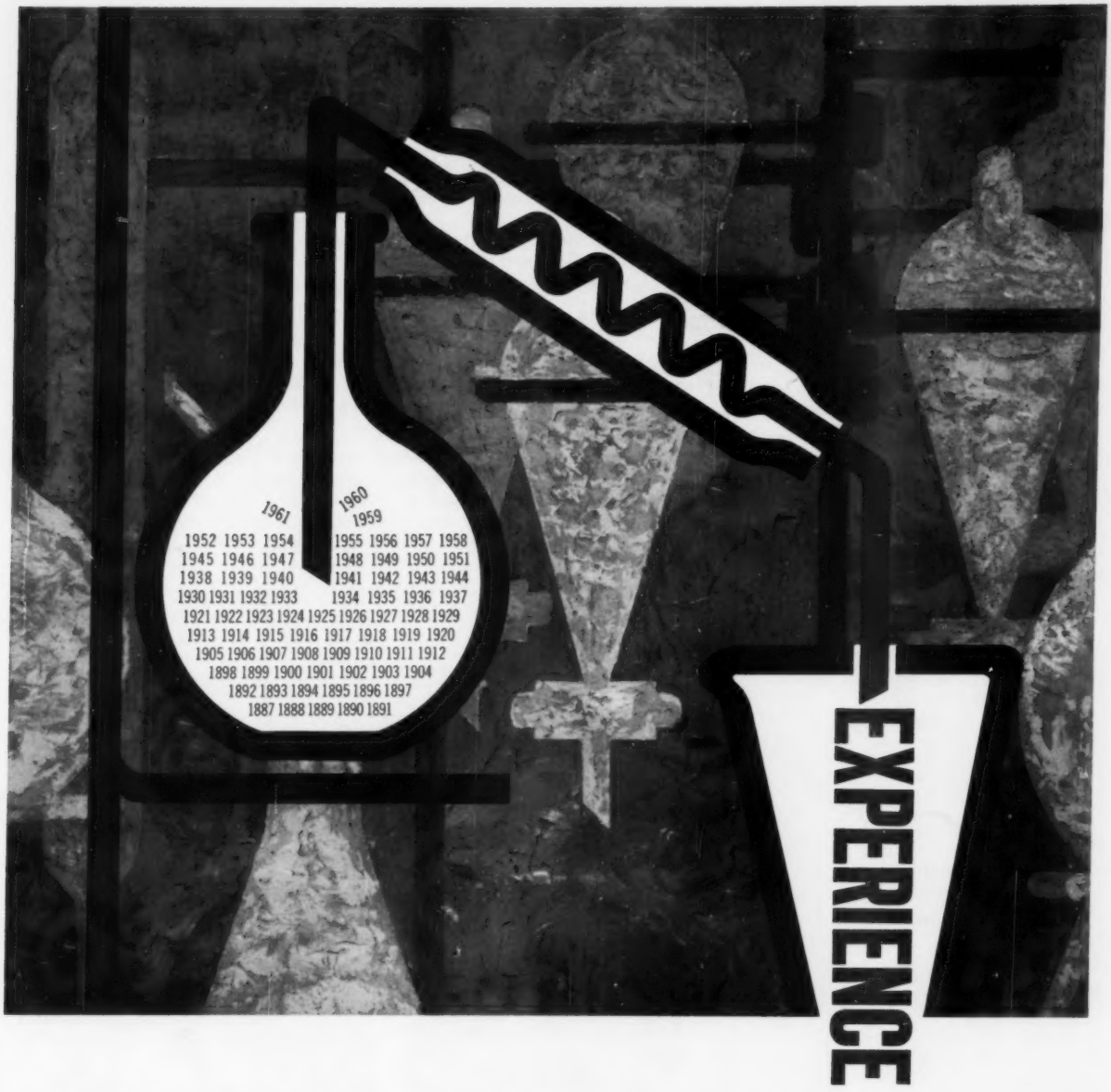
The scheduled increase in generating capability during 1961 is proceeding according to plans to bring the total power-producing capability of the industry to 188 million kw in December 1961. This will be an increase of 7.4 per cent above the actual capability of 175 million kw in December 1960. By the end of 1964, this figure is expected to reach 221 million kw.

BUREAU OF RECLAMATION has awarded a $39.8 million contract for construction of Yellowtail dam and power plant on the Bighorn River in Montana. The dam will be the largest concrete structure of its kind to be built by the Bureau of Reclamation on the Missouri River Basin Project.

Low bid of $39,809,359 was submitted as a joint venture consisting of Morrison-Knudsen Co., The Kaiser Co., Perini Corp., Walsh Construction Co., and F. & S. Contracting Co.

The Bureau of Reclamation has also awarded an $8,007,798 contract for manufacture of eight giant generators for the Glen Canyon power

Continued on page 76



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Someone once wrote: "The priceless ingredient of any product is the honor and integrity of its maker."

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who

John Tyner of POWER ENGINEERING

We are happy to announce that **John T. Tyner** has joined our staff in the capacity of Associate Editor. With a degree in Electrical Engineering from Illinois Institute of Technology, John comes to us with an excellent background, both practical and editorial, in the power field.

After graduation, he spent two years with a utility company, and then joined the staff of a power field magazine. Eight years of this editorial experience, plus a wide range of contacts in the power industry, qualify John Tyner most ably for his new position.

Mr. Tyner is married, has three children, and is a member of Triangle Fraternity. He has been quite active in AIEE, and is currently publicity chairman of the National Telemetering Conference. John is well known to many of our readers. We are proud to have him with us.

Murray A. Wilson, a consulting engineer of Salina, Kansas, has been elected president of the National Society of Professional Engineers. **Lief J. Sverdrup**, president and director of the engineering firm of Sverdrup & Parcel, has been selected to receive the Society's 1961 Award for outstanding service to the engineering profession.

Warren W. Johnston is now vice president-operations for Panellit Service Corp.

S. N. Fiala, vice-president and chief engineer of the American Electric Power Service Corp., has been elected a director of the parent company, American Electric Power Co. **Donald C. Cook** has been elected vice-president of American Electric Power and appointed assistant to the president.

Karl K. Kreamer has been elected vice-president in charge of operations of Houston Lighting & Power.

After 49 years of service, **J. William Robinson** has retired as manager of the Service and Repair Division, De Laval Steam Turbine Co.

H. L. Mann has been named chairman of the board and chief executive officer, and **R. W. Greenleaf** president, of Iowa Southern Utilities Co.

Dr. Robert W. Van Houten, president of the Newark College of Engineering and director of the Newark Technical School, has been selected as president of the American Society for Engineering Education.

Stone & Webster Engineering Corp. has named three new vice-presidents: **C. G. Davis**, a construction manager; **T. A. Fearnside**, manager of engineering; and **F. R. Stevens**, labor relations consultant and former personnel manager.

Dr. Ralph E. Hall, pioneer in the field of water treatment chemistry and director emeritus of Hagan Chemicals & Controls, died May 2 at his home in Rehoboth Beach, Del., at the age of 76.

C. A. Dauber joins Chas. T. Main

Clarence A. Dauber has been appointed to head the thermal power engineering activities of Chas. T. Main, Inc., Boston consulting firm. Dauber is presently director of the Civil and Mechanical Engineering Division for The Cleveland Electric Illuminating Co., and will occupy his new position on July 1.

what

Billy Lyford, Marianna (Fla.) High School senior, writes:

I want to thank you for the help you gave me in connection with my ion membrane fuel cell project recently entered in various Science Fairs and thought you might be interested in the results.

1. Marianna High School — First Place in Physics
2. Jackson County Science Fair — Chipola Junior College, Marianna, Florida—First Place in Physics.
3. Regional II State Fair—Gulf Coast Junior College, Panama City, Florida—First Place in Physics and No. 1 Award all entries.
4. State Fair at Florida Southern College, Lakeland, Florida—No award or recognition.

Here are a few general comments about the participation. In the first three fairs my cells worked satisfactorily both in series and in parallel and operated a push-pull motor. As a matter of fact at the Regional II State Fair the cells operated continuously for three days. In the State Fair at Lakeland, Florida, my luck failed and being pressed for time before judging nothing worked properly.

I enjoyed working with the fuel cell as a Science Fair Project and won a Chipola Junior College Scholarship valued at $150. Since I plan to enter Georgia Institute of Technology in the fall the scholarship cannot be used.

Thanks again for your assistance.

when

Electrical Apparatus Service Assn. meets at the Jack Tar Hotel, San Francisco, June 11-14.

Air Pollution Control Assn., June 11-15, Hotel Commodore, New York City.

AIEE, Summer General Meeting, at Cornell University, Ithaca, N.Y., June 18-23.

Joint Automatic Control Conference, June 28-30, at the University of Colorado, Boulder. Sponsors are AIChE, ASME, IRE and ISA.

National Society of Professional Engineers, July 4-7, at the Olympic Hotel in Seattle, Wash.

Fourth session of International Reactor Progress in Nuclear Reactor Operations Supervision and Nuclear Reactor Hazards Evaluation will begin September 25 at Oak Ridge National Laboratory. June 15 is deadline for submitting applications to attend.

Water Pollution Control Federation, 34th annual meeting, Oct. 9-12, in Milwaukee, Wis.

Eighth Industrial Electric Exposition, Nov. 7-9, in the Penn-Sheraton Hotel, Pittsburgh. Sponsored by the Electric League of Western Pennsylvania.

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Current news reports

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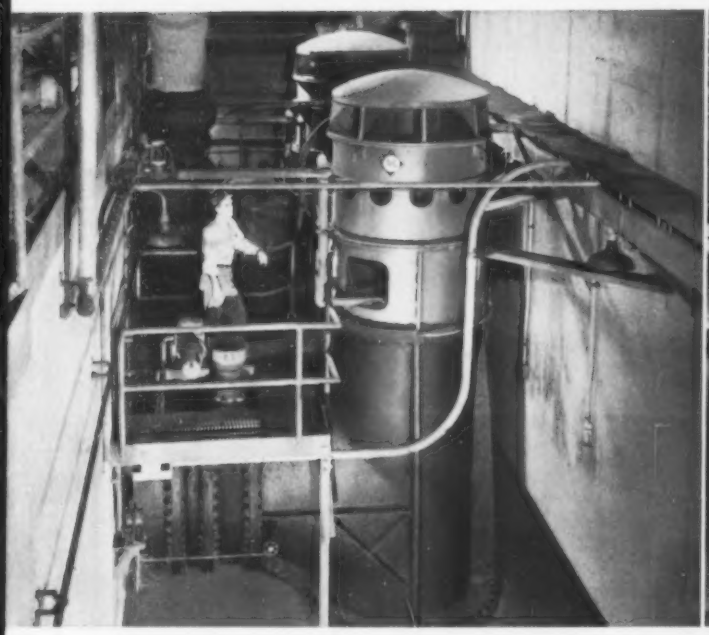
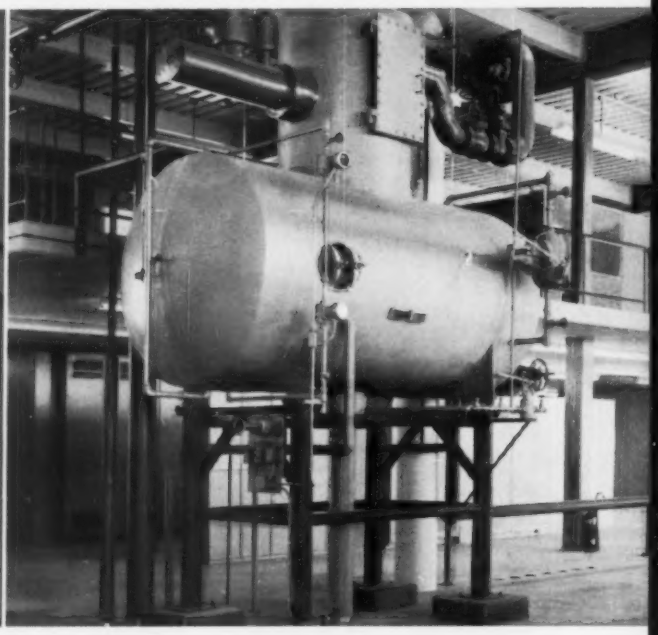
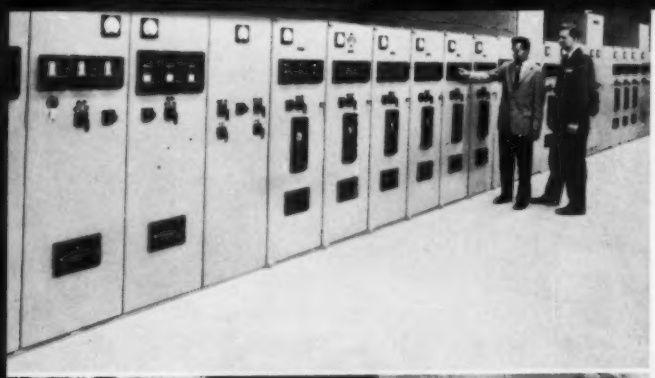




Rugged construction for continuous operation at highest possible efficiencies — yours with these condenser circulating water pumps and vertical induction motors. All pumps are tested at rated head and capacity to assure guaranteed performance. Available in a wide variety of materials to meet your installation needs. *Super-Seal* motors, with *Silco-Flex* insulation, assure complete reliability for outdoor installations and areas with high humidity or contaminated atmospheres.

Stainless steel "scorns" corrosion — It's standard with all Allis-Chalmers tray-type deaerator internals. This 90,000 lbs. per hour "package" unit removes oxygen and other corrosive gases besides heating boiler feedwater. Heating and distributing tray design provides greater spillage edge — extra-efficient air separating trays remove more oxygen and gases through full counterflow design. Protects boiler and associated steam and condensate equipment from corrosive attack.



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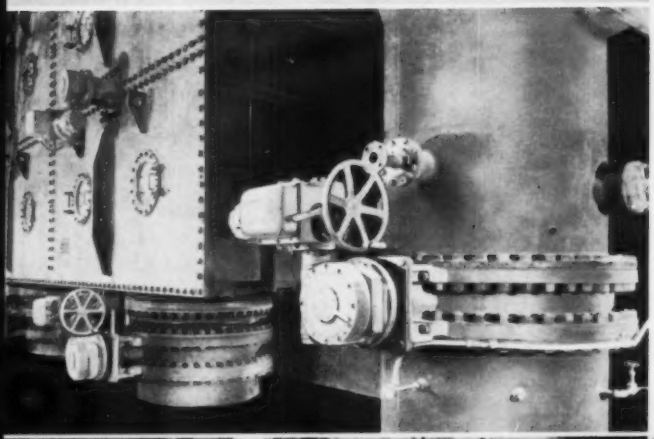
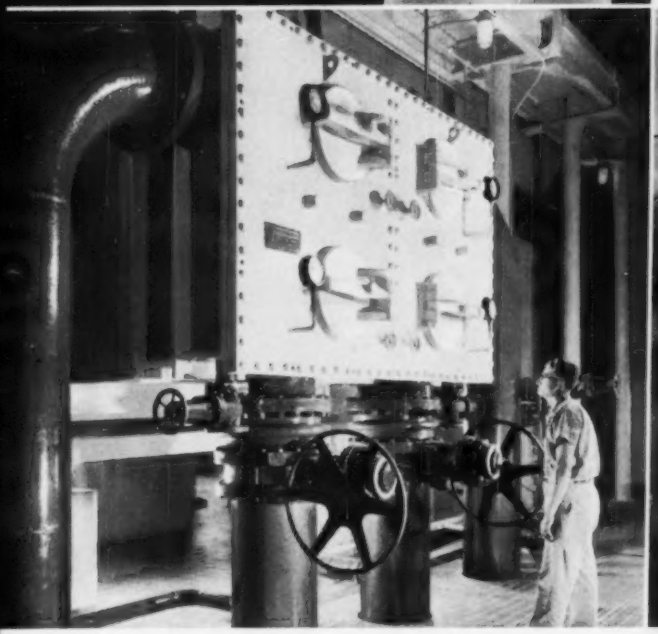
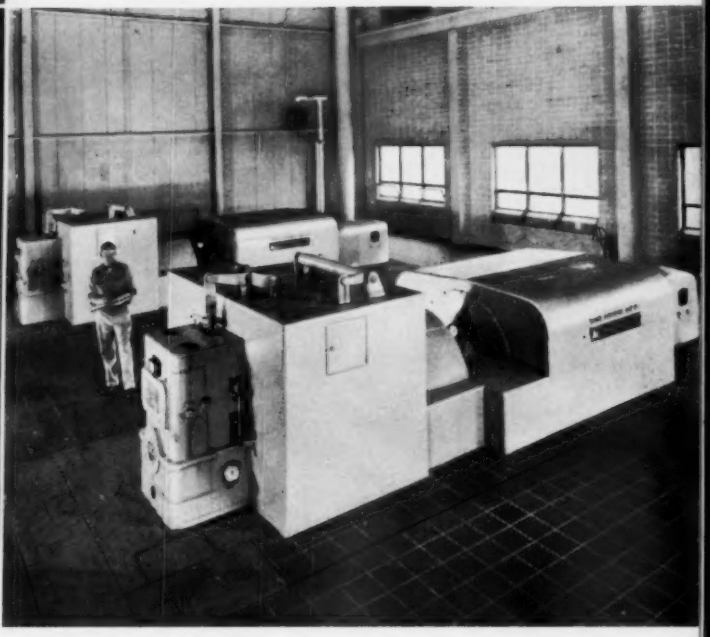


Eliminate tuberculation and oxidation, reduce maintenance with rubber-seated butterfly valves. Operation is always extra-smooth and easy with 100% effective shutoff. Full body protection is offered by a rubber seat that extends through the valve body and over the flange faces. Angle seating protects the rubber seat and permits seating adjustment without costly disassembly. Being light and compact, these valves require less space and support than most other types.





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A-1479

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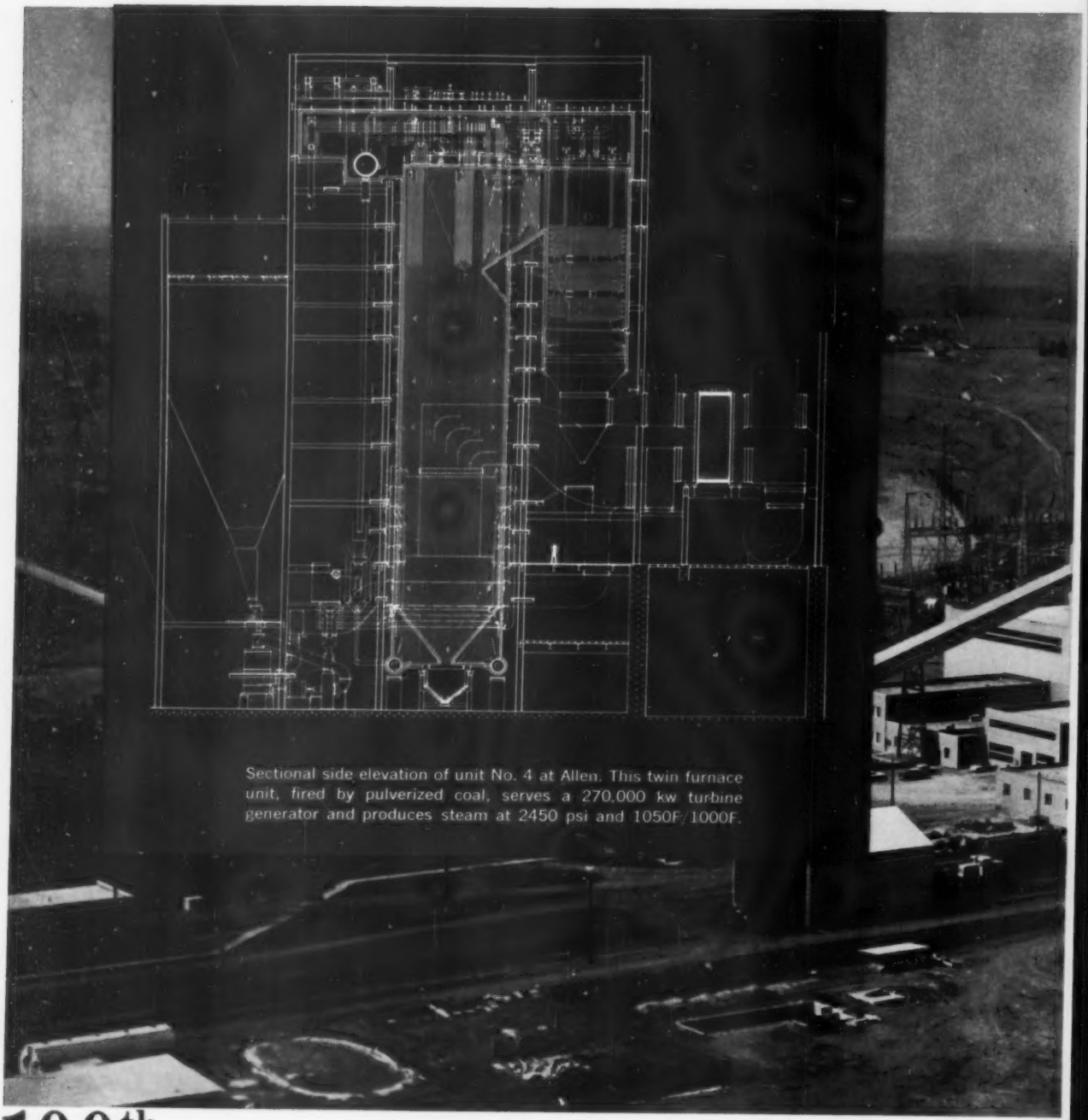


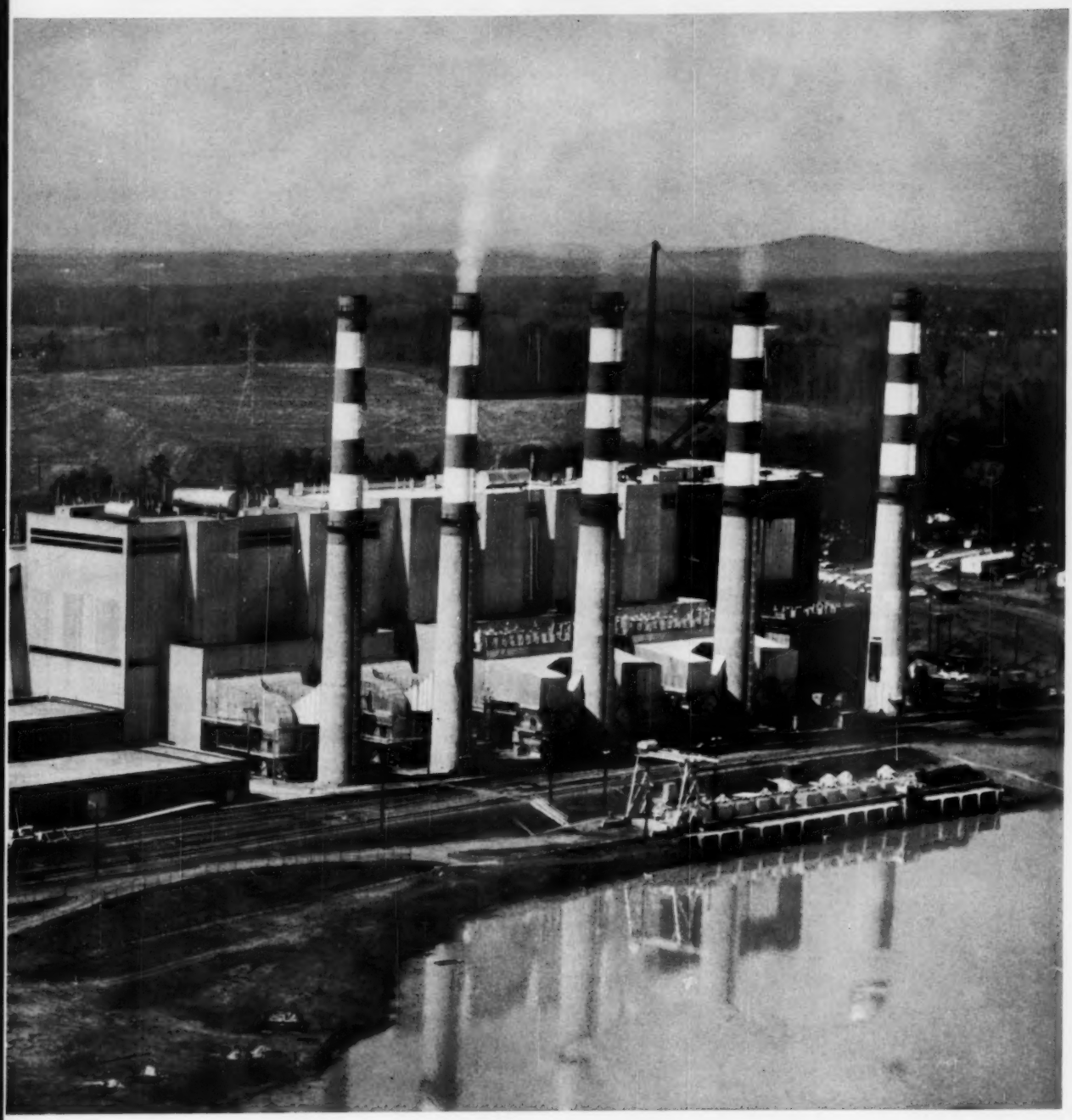
Sectional side elevation of unit No. 4 at Allen. This twin furnace unit, fired by pulverized coal, serves a 270,000 kw turbine generator and produces steam at 2450 psi and 1050F/1000F.

100th C-E CONTROLLED CIRCULATION

Late in 1960, C-E's one hundredth Controlled Circulation Steam Generator was placed in operation. Located at Duke Power Company's Allen Plant, this, the fourth Controlled Circulation unit in service at Allen, will soon be joined by a fifth, now under construction. The Duke Power system presently has more than 2,300 mw of Controlled Circulation generating capacity, installed or on order.

Since the first postwar C-E Controlled Circulation unit was placed in service about eight years ago, this type of unit has established itself as the design best suited for the 2400 lb throttle pressure

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;



UNIT NOW IN SERVICE

range, and has achieved unparalleled acceptance throughout the utility industry. Today, units of this design are on order, under construction, or installed in utility plants the world over. The total capacity of the turbine generators served is about 30,000 mw.

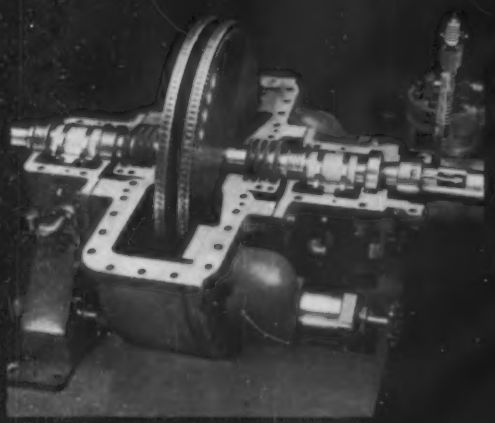
COMBUSTION ENGINEERING C-E

C-314

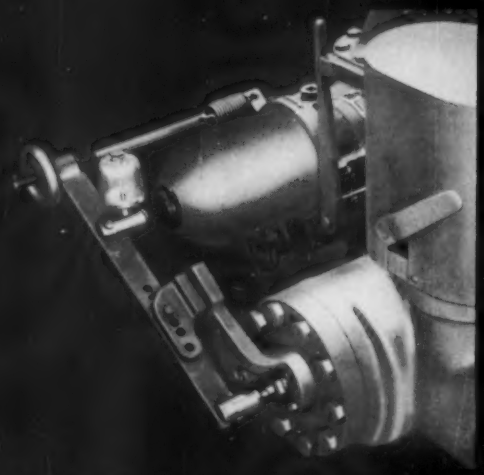
General offices: Windsor, Connecticut
New York offices: 200 Madison Avenue, New York 16

PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

For more data circle 508 on Post Card



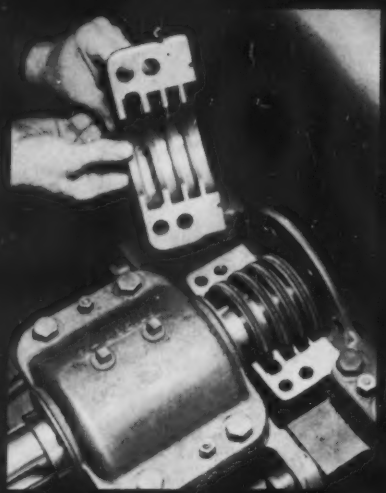
Precise alignment of shaft, through true centerline support, permits smooth and dependable operation at all operating temperatures.



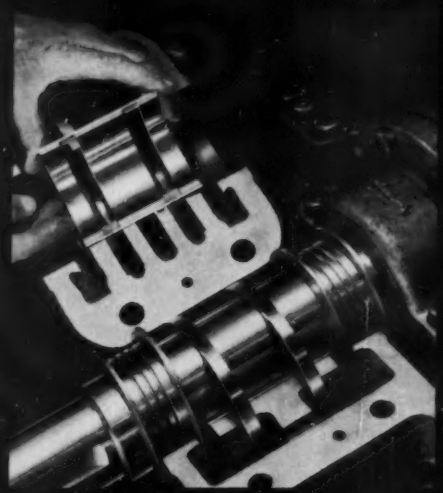
Simple, positive direct-acting speed-governing system is dependable, weather-proof, accurate. Separate trip gives positive overspeed protection.

These features mean dependable, economical turbine operation:

1. True centerline support
2. Positive speed control
3. Accessible shaft seals
4. Inexpensive bearings
5. Optional hand valve
6. Full protection



Accessible shaft-seals simplify maintenance and routine inspection. Covers readily removed without disturbing casing.



Inexpensive liner-type bearings readily installed with no scraping, fitting or adjustment required.

Steam-saving hand valve with pilot, which can be opened against full steam pressure, reduces steam consumption at partial loads.

All-weather protection is standard for Elliott YR turbines. They shrug off heat, snow, moisture, dust or contaminated atmosphere.

Six marked differences make Elliott turbines a better buy

Why are Elliott YR turbines your best choice for mechanical drives? Some of the reasons are described on the opposite page. These are tangible reasons why you can expect dependable, economical operation with little care or attention.

With more than 50 years' experience in mechanical-drive turbines up to 50,000 hp; with the most complete line of field-proven machines; with engineering and service facilities nationwide: Elliott is clearly "Turbine Headquarters." Write for bulletin H22-D.

TURBINES FOR DEPENDABLE day-in/day-out SERVICE

ELLIOTT COMPANY

GENERAL OFFICES: JEANNETTE, PENNSYLVANIA

PLANTS AT: Jeannette and Ridgway, Pa.; Springfield, Ohio

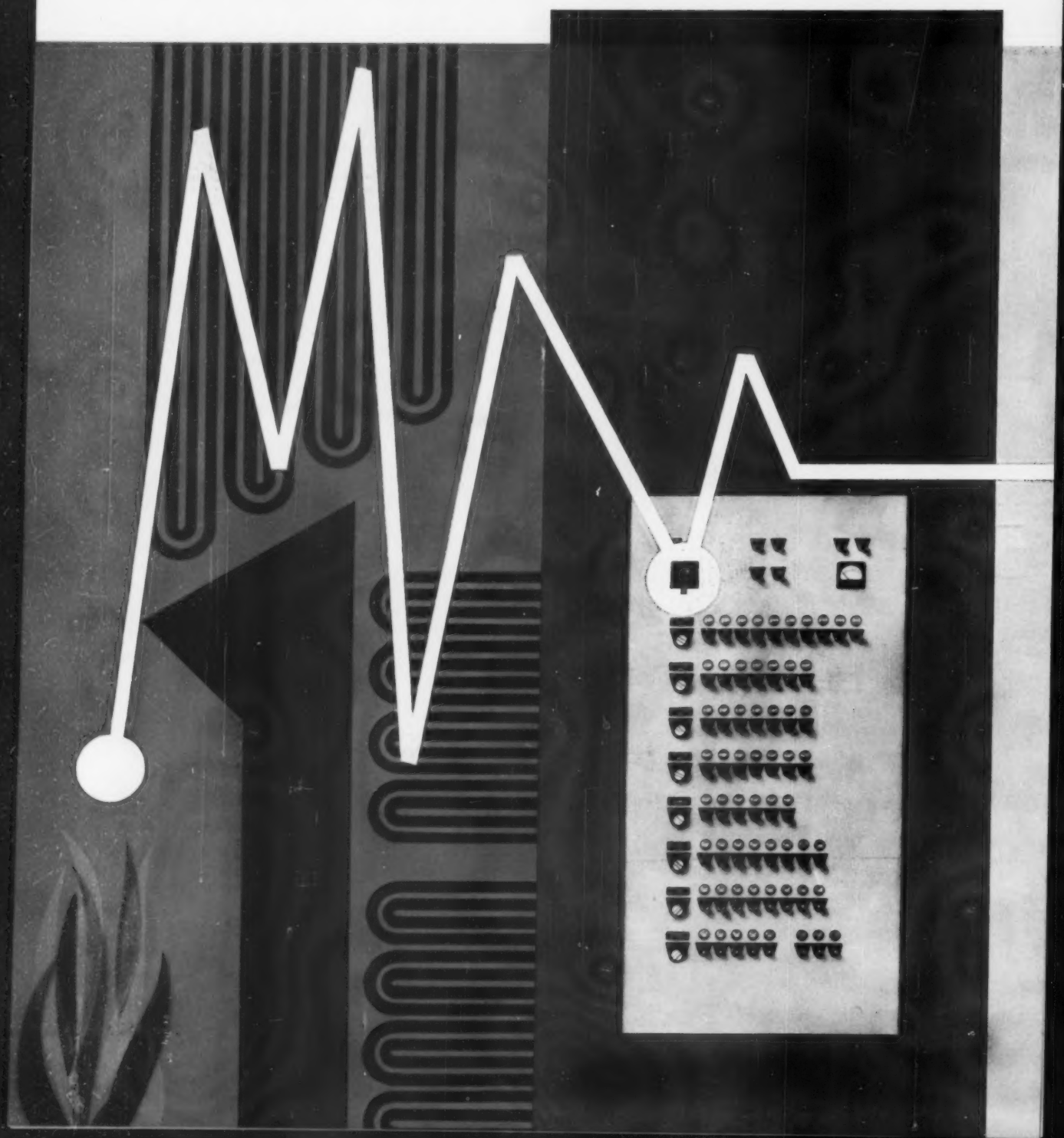
TURBINES • GENERATORS • MOTORS • COMPRESSORS
TURBOCHARGERS • EJECTORS • STRAINERS • TUBE CLEANERS

H1-1

For more data circle 509 on Post Card

Diamond developed for more economical power

MONITORMATIC...NEW SELF-CONTROL FOR MORE EFFICIENT BOILER CLEANING



Optimum frequency of blower cycling is assured with Monitormatic . . . Diamond's completely automatic boiler cleaning system.

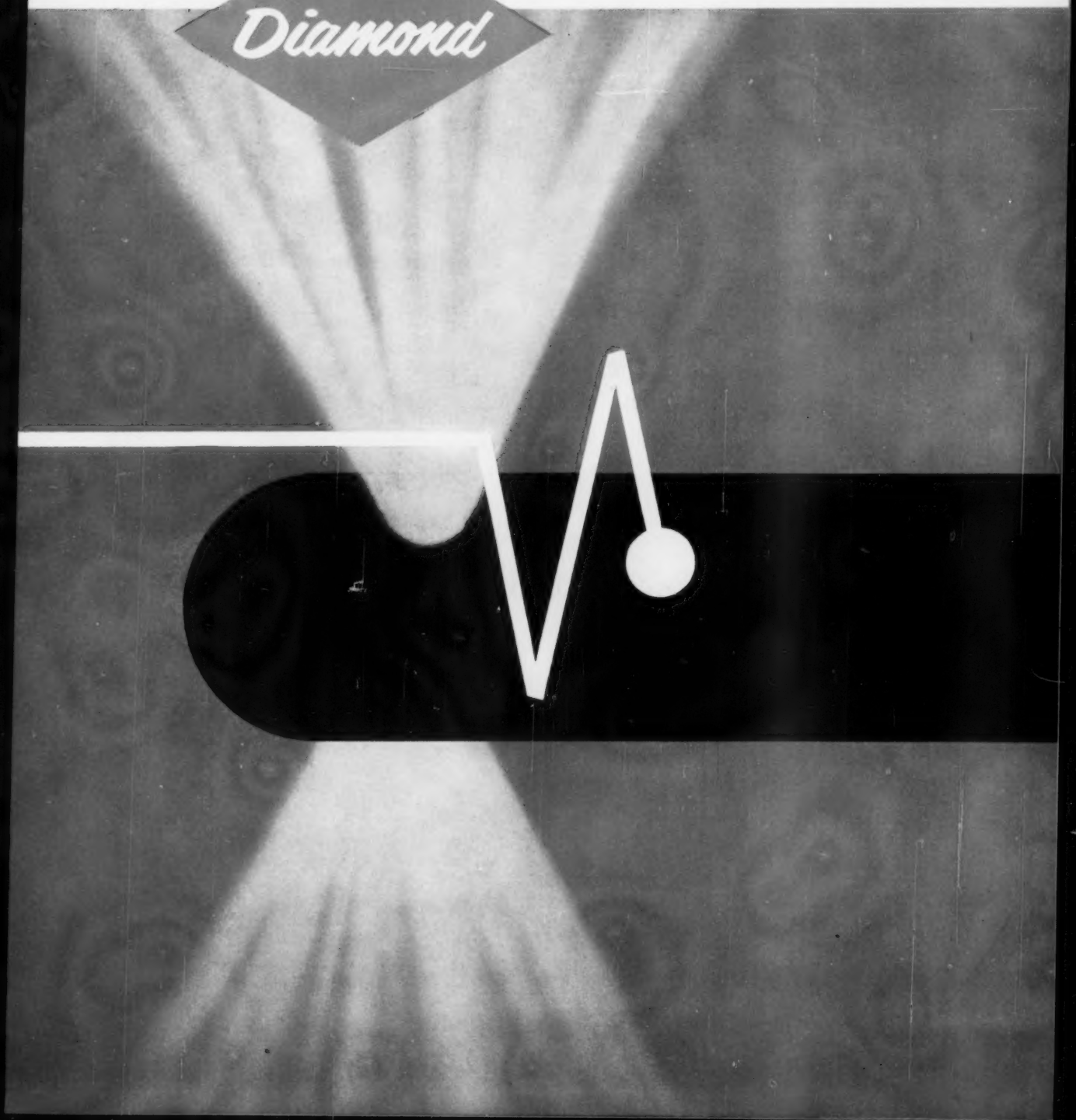
Monitormatic is an automatic method of maintaining constant furnace cleanliness and heat absorption. It responds automatically to changing boiler conditions and eliminates indiscriminate, unnecessary or insufficient blowing. Savings are realized through optimum use of blowing medium, minimized soot blower maintenance, less compressor maintenance if air is used as blowing medium, and reduced operator time. It also automatically adjusts the cleaning system to fuel changes.

Monitormatic is readily and economically applicable to new or many existing Diamond Selectromatic Systems; is another example of why "Diamond Developed" means more economical power generation.

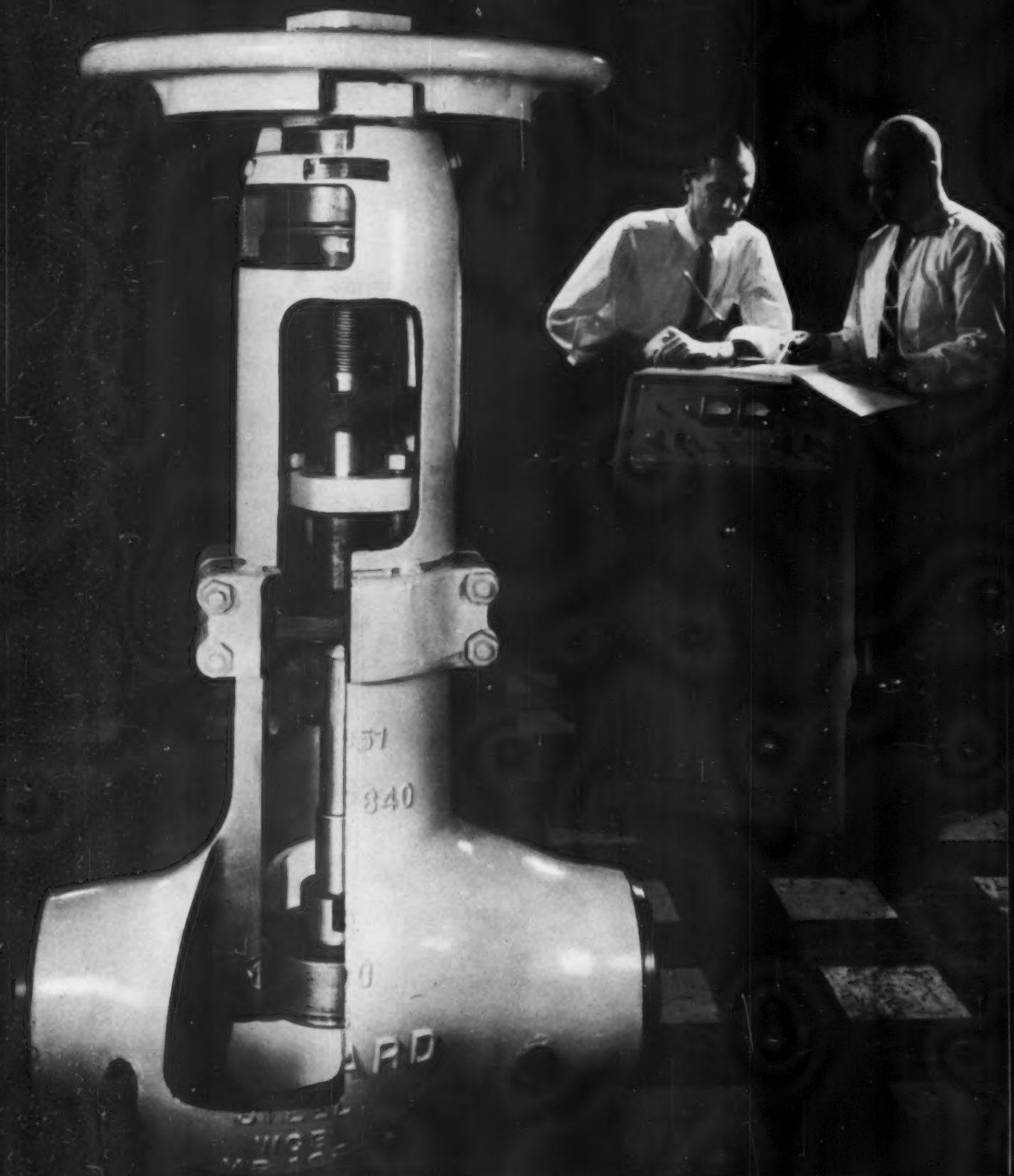
At your request, our Engineers will be pleased to evaluate the application of Monitormatic to your specific system. Call, write or wire for complete information.

DIAMOND POWER SPECIALTY CORPORATION, Lancaster, Ohio

DIAMOND SPECIALTY LIMITED, Windsor, Ontario



The Story of Edward Research



and the Pressure-Seal* Valve

The introduction, in 1945, of commercial steel valves with pressure-seal bonnet joint construction was a significant advance in the art of building large high-pressure steel valves. The new pressure-seal construction eliminated massive flanged bonnet joint connections and made it possible to seal the valves permanently at high temperature. These advantages were immediately apparent to users everywhere. But bonnet joint leakage problems developed on the new valves in service. And Edward engineers soon became convinced that the original 45° pressure-seal gasket design used by Edward and others required improvement. Here's the Edward pressure-seal redesign story:

INITIAL TESTING—Edward engineers began their studies on leak problems in 45° gasketed pressure-seal valves by determining under what conditions the valves were most likely to leak. It was discovered that when sealing areas were thoroughly degreased and tested with air, the pressure seal would leak at all pressures above 10 psi. In addition, minute imperfections in the sealing area of the valve body bore were preventing intimate gasket contact and contributing to leakage. Edward engineers found that a broader area of contact between gasket and bonnet and between gasket and body bore would also reduce leakage. Further investigation showed that a gasket plating material softer than the silver plating previously used would be helpful in achieving better contact in the sealing area.

To obtain more gasket sealing area, experiments were conducted on gaskets with angles from 45° down to 17°. Over a period of several months, tests were made with 25 different combinations of gasket and bonnet angles and various gasket plating materials. Assembled valves were tested for tightness with air pressures ranging from 10 psi to 2160 psi, and at temperatures up to 1000 F for extended periods. And tests on ease of valve disassembly (an important user consideration) were made with each gasket combination.

TEST CONCLUSIONS—At the end of their extensive testing program on the pressure-seal design, Edward engineers were able to draw these conclusions:

1. 45° gaskets, which showed no leak on water tests, leaked air at similar pressures.
2. No gasket of any design, either plain or with a plating of 100 Brinell or harder, would seal air when assembled unlubricated.
3. The best sealing under test resulted with a 25° gasket angle which was 1° more acute than the bonnet angle.
4. Gaskets of 25° angle actually tripled the sealing surface area.
5. A stainless inlay in the valve body bore sealing area substantially improved gasket-to-body contact and provided a corrosion-resistant surface.
6. Gaskets of 25° angle, plated properly with a malleable coating, gave perfect air or steam sealing at all temperatures, whether assembled dry or with a lubricant.

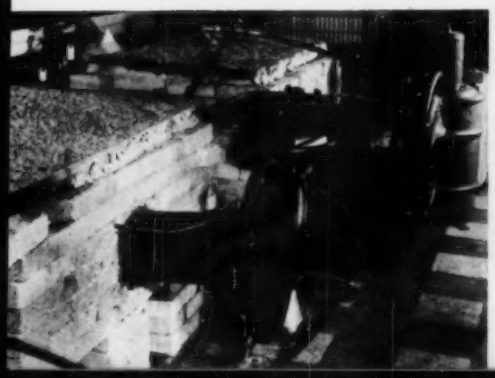
NEW VALVE DESIGN—As the result of their tests, Edward engineers designed the completely new pressure-seal valve with 25°-65° joint (see diagram below). This change in gasket angle, with an increase in sealing surface area, and the addition of a special corrosion-resistant malleable coating, brought an end to bonnet joint leakage in Edward pressure-seal valves. And, since 1953, thousands of Edward pressure-seal valves have been installed in a great variety of services *without a single case of failure reported to date.*

The story of Edward research and the pressure-seal valve is typical of the kind of research progress and product leadership you can expect from Edward Valves. Edward builds a complete line of forged and cast steel valves from ⅛" to 18" for industrial, marine, petroleum and technological services. For more detailed information, contact your Edward Representative, or write Edward Valves, Inc., 1202 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 438 St. Peter Street, Montreal.

*Patented

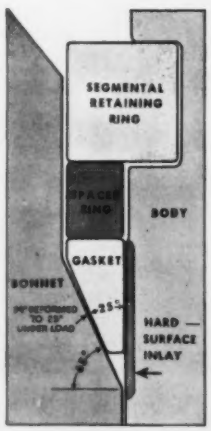
EDWARD STEEL VALVES
another fine product by
ROCKWELL

P. J. DUKES, product development engineer, and D. MacGregor, works manager, are shown with helium leak detector used in testing pressure-seal valve joints.



SPECIAL GAS-FIRED FURNACES were used in temperature testing of new pressure-seal valve design. Furnaces heated valves up to 900 F for 24 hour periods. Pressure was maintained with hydro-pneumatic pumps.

NEW 25° GASKET DESIGN



For more data circle 511 on Post Card

Owner: **Western Hotels, Inc.**
Electrical Engineer: **Mr. Fritz Klawa,** Portland, Ore.
Electrical Contractor: **Pitman Electric Co.,** Portland, Ore.

Electrical Protection is MODERNIZED with BUSS Fuses in the Multnomah Hotel, Portland, Ore.

In this well-known hotel of the Northwest, it became necessary to modernize the electrical system to take full advantage of the many uses for electricity today.

BUSS Hi-Cap and FUSETRON dual-element fuses were installed to assure safe, dependable and lasting protection.

This installation is another example of the modern trend in electrical protection. Architects, engineers and plant operating men are finding no other type of protective device can equal fuses for high-interrupting capacity and lifetime, maintenance-free dependability.

FUSES PROVIDE HIGH INTERRUPTING CAPACITY

at a very low cost

FUSETRON dual-element fuses have an interrupting rating of 100,000 ampere rms symmetrical—and for the protection of mains or circuits above 600 amperes, BUSS Hi-Cap fuses are designed to safely interrupt 200,000 ampere rms symmetrical.

Thus, they can safely interrupt fault currents now available,—and are adequately safe to allow for future system growth.

Mr. J. Wesley Birch, Manager of Pitman Electric Co. at main switch board which is equipped with BUSS Hi-Cap and FUSETRON dual-element fuses.

If you need fuses with long time-lag to prevent needless blows, plus 200,000 amp interrupting capacity, plus extreme current-limitation—use **BUSS LOW-PEAK** fuses.

Ask for BUSS bulletin LPCS.

WITH FUSES, SAFE PROTECTION REMAINS SAFE WITHOUT MAINTENANCE OR RECALIBRATION COSTS

After years of inactivity, fuses will provide the same safe, accurate protection if called upon to open as they would on the day installed.

Fuses have no hinges, pivots or contacts to stick or get out of order. Dust, fumes, corrosion or age cannot increase the capacity of fuses or lengthen their blowing time.

For more information:

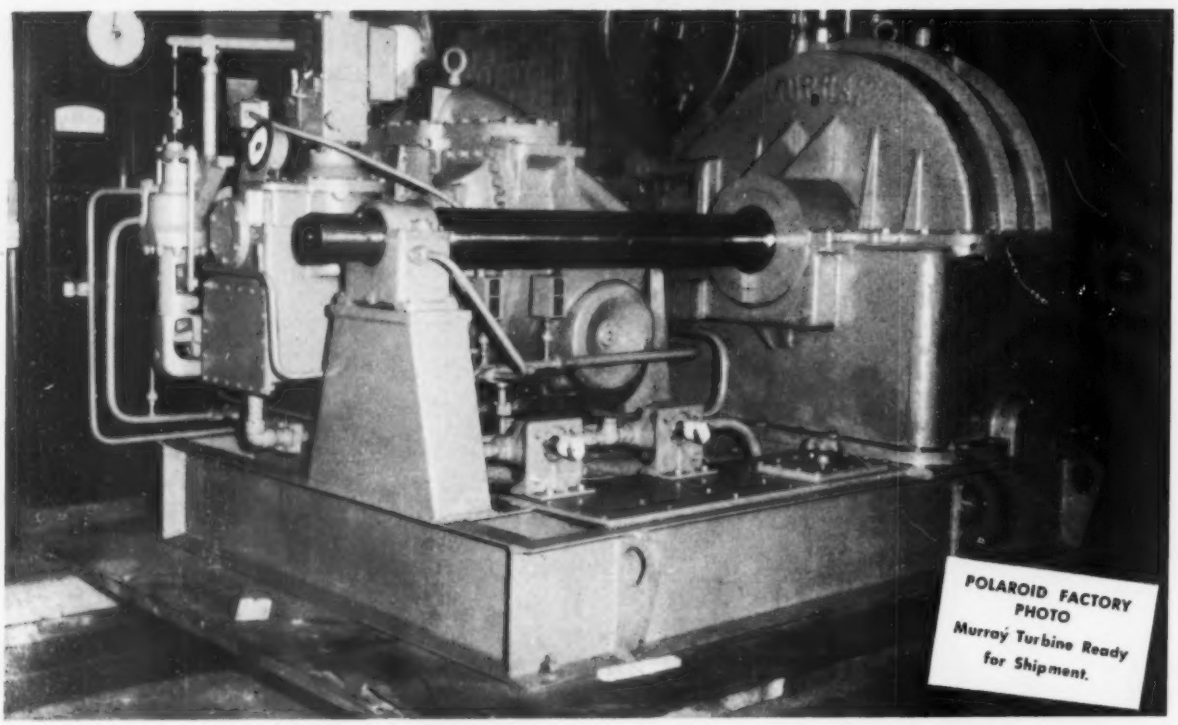
Fusetron dual-element fuses.....write for bulletin FIS
BUSS Hi-Cap fuses.....write for bulletin HCS

BUSSMANN MFG. DIVISION, *McGraw-Edison Co.*
University at Jefferson, St. Louis 7, Mo.

561

For more data circle 512 on Post Card

Murray
TURBINES



A 750 H.P. 5800 RPM Type U Murray Turbine and gear with double extended low speed gear shaft for driving paper machine at from 750 to 75 RPM. Steam conditions: 600 PSIG 750°, 50# exhaust.

Murray Iron Works Company Turbines are built to stand up for many years of trouble-free economical operation. Each unit is engineered to the highest standards providing continuous service and precise speed control as required for paper machine drive.

Spare parts fit properly as received from the factory regardless of the number of years the turbine has been in service . . . proof of attention to detail both in engineering and shop craftsmanship!

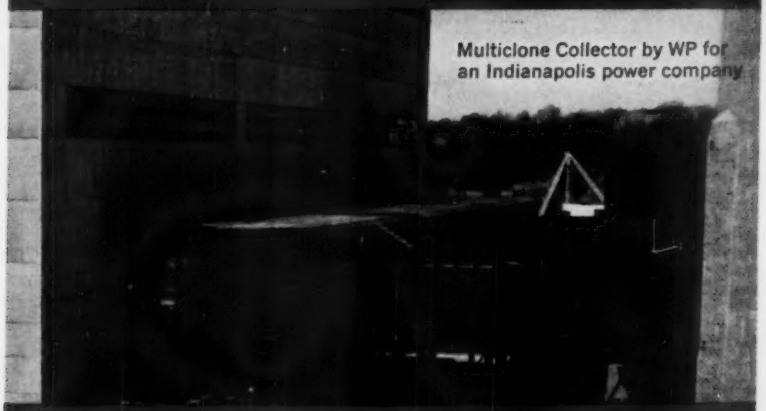
The true economy of Murray Turbines speaks for itself after years of trouble-free operation. Write today for information on Murray Turbines to meet your requirements.

Murray

IRON WORKS COMPANY • BURLINGTON, IOWA

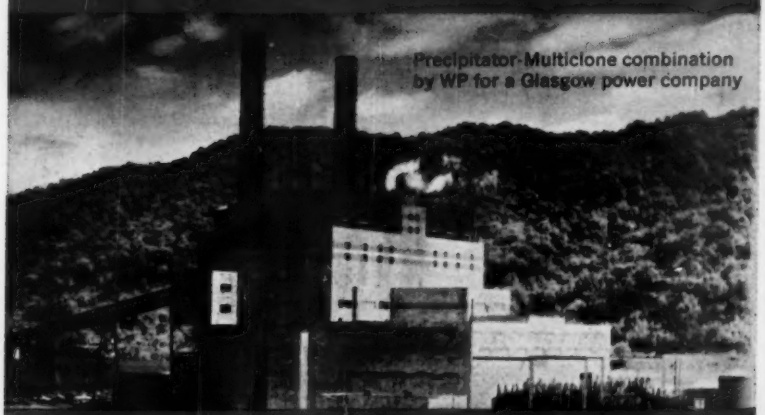
Builders of Steam Power Equipment for Nearly a Century

For more data circle 513 on Post Card



Multiclone Collector by WP for an Indianapolis power company

Power plants in Indiana... and West Virginia...agree:



Precipitator-Multiclone combination by WP for a Glasgow power company

When DUST is your problem— CLEAR IT WITH WP*

For an efficient, economical solution to any dust control problem—look to Western Precipitation. WP is uniquely fitted to handle your unique problem—being the one organization that custom designs, engineers and installs ALL types of dust and fume control equipment: Precipitator, Mechanical, Jet-Cleaned Filter, Hi-Temp Filter, Scrubbers and engineered combinations.

With no axes to grind for any one system, WP engineers will give your job a completely unbiased recommendation—whether it's a quote on your specifications, a single component, or a completely engineered installation ... small, major, simple, or complex.

An inquiry—on your business letterhead—will bring you literature promptly. Just write Western Precipitation, 1000 W. 9th St., Los Angeles 54, Calif. (In Canada, write 8285 Mountain Sights Ave., Montreal, P.Q.)

Dust and fume control since 1907

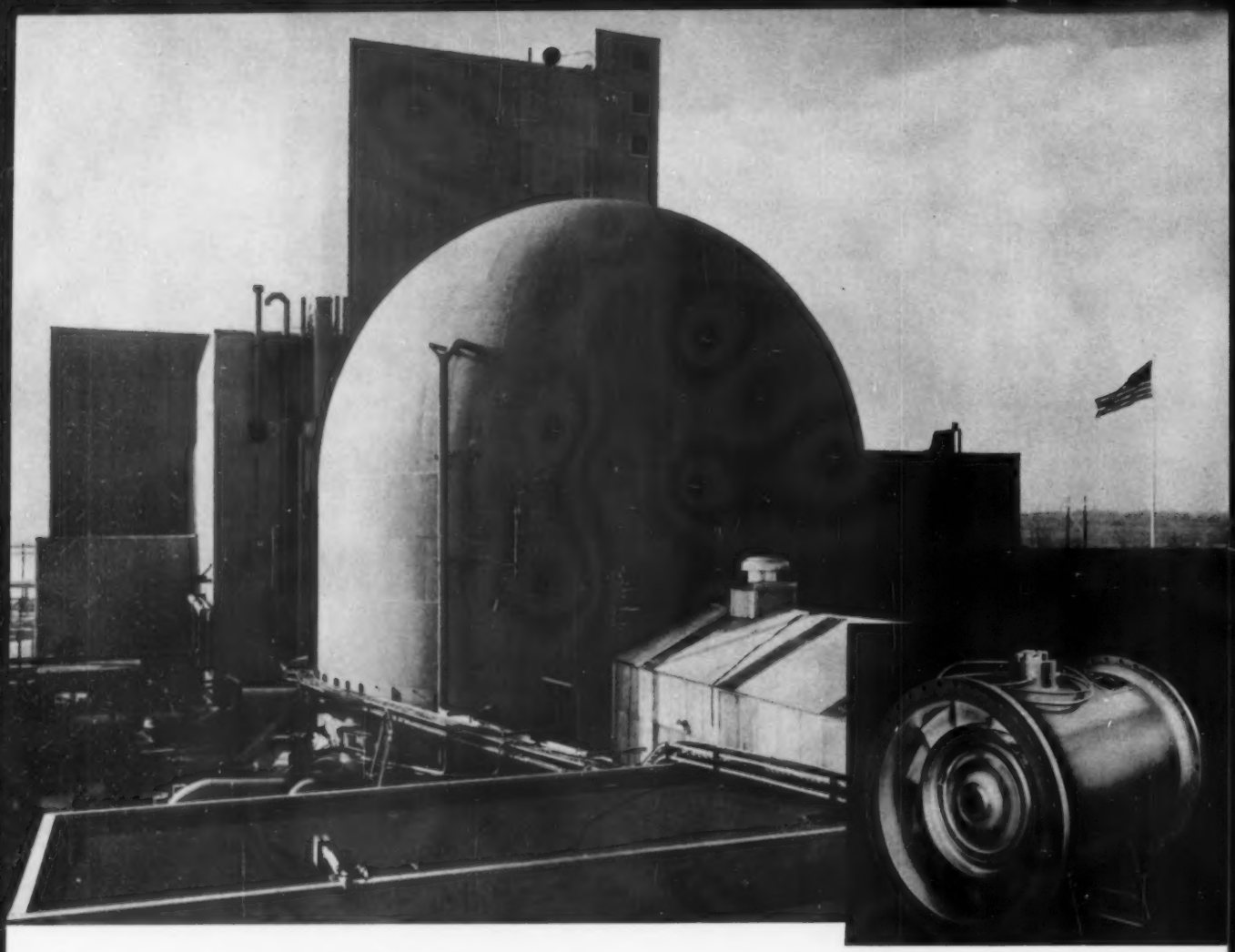
*WESTERN PRECIPITATION

Los Angeles 54 • New York 7 • Chicago 2 • Pittsburgh 22 • Atlanta 5 • San Francisco 4

Division of Joy Manufacturing Company

ELECTROSTATIC Precipitators
MULTICLONE Collectors
CMP Combination Units
DUALAIRE Jet-Cleaned Filters
THERM-O-FLEX Hi Temp Filters
TURBULAIRE Scrubbers
JOY-MICRODYNE Scrubbers
also: HOLO-FLITE Processors
HI-TURBULANT Heaters
TURBULEX Processors

For more data circle 514 on Post Card



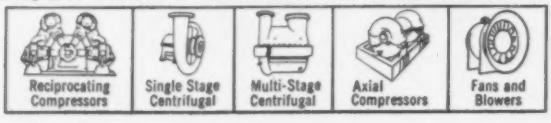
Two-stage JOY Axivane® Fans provide lower vessel ventilation at Enrico Fermi Atomic Power Plant

A special two-stage Joy Axivane Fan circulates the enclosed nitrogen atmosphere which provides lower vessel cooling for the world's largest fast neutron breeder reactor. Rated at 100,000 KW, the Enrico Fermi plant built by Power Reactor Development Company and The Detroit Edison Company will be among the largest atomic power plants in operation. In addition to handling the critical lower vessel cooling, Joy also provided the heavy duty fan for dilution of stack gas.

Joy Axivane Fans are ruggedly built to meet the most demanding service requirements. Power consumption is held to a minimum, because Joy Axivane Fans have adjustable pitch blades which can be set for any desired volume of air over a wide range. Drive motors can always be operated at their most efficient speed. To conserve space and cut installation costs, these fans can be mounted directly in the duct—motors are integral. V-Belt drive is available if desired.

Whenever you need heavy duty, economical ventilation fans, consult your Joy representative. For complete information on Joy fans, write for Bulletin 2549-56C.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY



JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

For more data circle 515 on Post Card

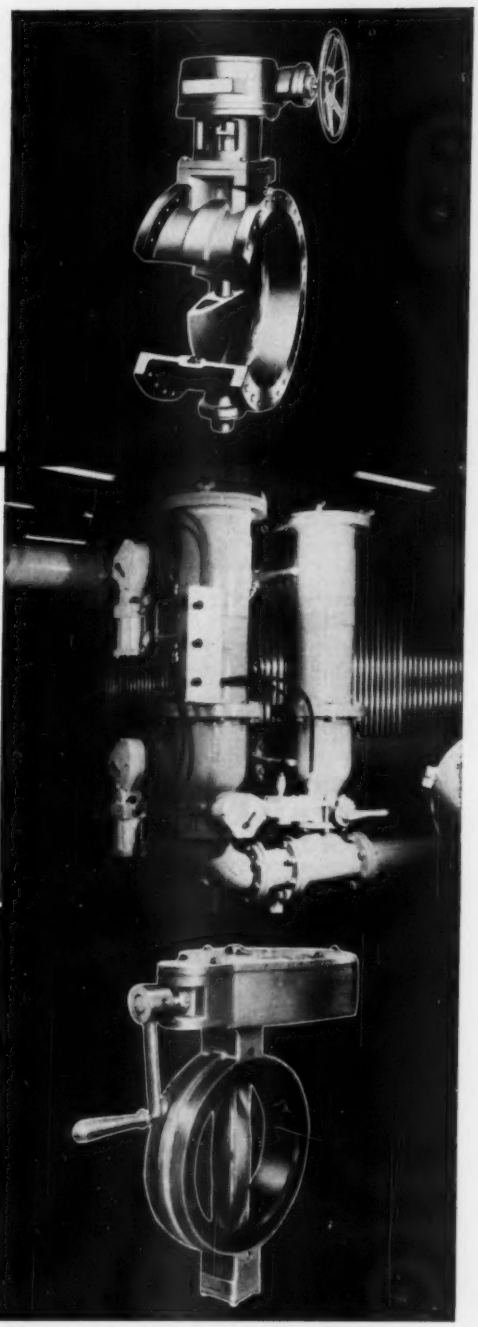
PRATT POWER PLANT PRODUCTS are all NEW for the '60's

NEW Rubber Seat Butterfly Valves

The time-proven Henry Pratt features are now augmented by such new design features as: ADJUSTABLE SEAT that can be tightened, or even replaced without removing shaft or disc. LOWER SEATING TORQUES, lowers actuator cost and provides remarkable ease of operation. Longer operating life through accurate control of disc-seat interference, giving tightness, without wear.

The new Pratt Butterfly Valves are available in sizes 3″ through 144″ and for pressures to 150# in both wide and narrow face-to-face. Also furnished with integral expansion joint.

Write for complete information.



NEW PRATT CYCLONE STRAINER

The new Pratt Cyclone Strainer eliminates the manual cleaning usually associated with this type of equipment. Backwashing operations are completely automatic and can be accomplished in seconds.

Unique design simplifies piping and installs for *far* less than ordinary designs.

Patented "Cyclone" action keeps larger particles away from oasket—keeps strainer "on the line" longer.

Features rubber seat butterfly valves for longer life and positive action. Manual or automatic valve operators.

Write for Bulletin S-1-K.

NEW Monoflange Mark -II

No valve is easier to install or operate. The Monoflange fits between existing pipe flanges—no gasket is necessary. With completely tight shut-off at 150# psi, the Monoflange Mark II finds many applications where economy is paramount, but long life is necessary.

New "Sidewinder" manual operators are available for standard or buried service with crank, handwheel or chainwheel. Cylinder, Diaphragm topworks or electric motor operators also available.

Write for Bulletin D-10-K.

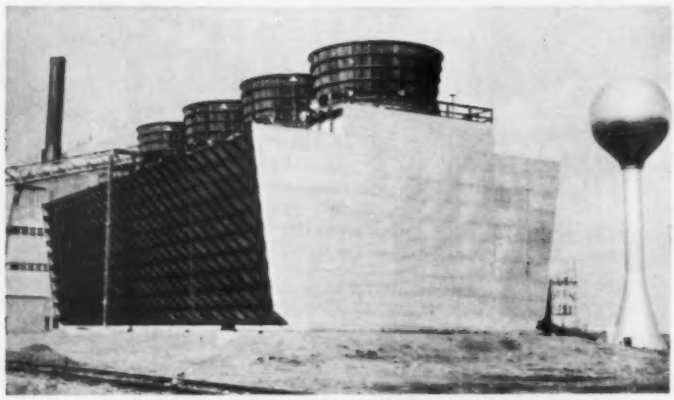
HENRY PRATT® Creative Engineering for Fluid Systems

HENRY PRATT COMPANY
319 W. Van Buren Street, Chicago 7, Illinois
Representatives in Principal Cities

For more data circle 516 on Post Card

As a matter of public record, here are Marley's

1960 TOWER TESTS



This Class 600 Double-Flow is typical of towers tested (see Test No. 12)

Again Marley is pleased to present its "annual report" to industry—the consecutive results of all acceptance tests* of Marley industrial cooling towers made in 1960. This series of tests demonstrates that The Marley Company is adhering rigidly to its established policy that every cooling tower proposed shall have ample capacity to perform in accordance to purchaser's specifications . . . after compensating for every contingency that may affect operating conditions. Every plant or process served by these Marley towers operated with specified cooling capacity from start-up date; no delays for alterations or additions were experienced by any of these Marley customers.

Test No.	TYPE OF SERVICE AND LOCATION	SPECIFIED CONDITIONS				TEST RESULTS[2]	
		Gallons Per Minute	Hot Water Temp.	Cold Water Temp.	Wet Bulb Temp.	Degrees[1] Cold Water Temp.(F°)	Percent Capacity
1	Generating Station—Gulf Coast	20,000	102.0	87.0	80.0	+0.6°	+10.8
2	Generating Station—Southwest	58,000	105.2	86.0	70.0	+1.6°	+9.7
3	Generating Station—South	1,700	111.5	95.0	80.0	+0.8°	+4.8
4	Generating Station—South Central	800	105.5	90.0	76.0	+0.9°	+7.0
5	Generating Station—Mid-Central	11,850	102.5	90.0	78.0	+1.1°	+8.4
6	Chemical Plant—Northeast	5,100	105.0	85.0	75.0	±0.0°	±0.0
7	Generating Station—Southwest	36,800	102.6	81.3	67.5	+0.6°	+3.8
8	Generating Station—Gulf Coast	116,200	110.7	92.0	76.0	+0.25°	+1.7
9[3]	Petroleum Refinery—Mid-Central	22,500	99.1	85.0	75.0	+0.1°	+0.7
10[3]	Generating Station—Southwest	63,000	106.0	90.0	75.0	±0.0°	±0.0
11	Air Conditioning—Mid-Atlantic	18,000	96.0	86.0	79.0	+0.1°	+1.25
12	Generating Station—Mid-Central	30,000	103.0	87.0	75.0	+0.7°	+5.0
13	Chemical Plant—Mid-South	9,000	102.0	85.0	78.0	+1.0°	+12.7
14	Chemical Plant—Mid-Central	9,200	110.0	80.0	71.0	+0.4°	+3.7
15	Air Conditioning—East Central	4,780	96.5	86.5	80.0	+0.85°	+10.6
16	Air Conditioning—East Central	2,940	98.8	82.7	78.0	+0.34°	+6.5
17	Air Conditioning—East Central	7,500	95.0	85.0	78.0	+0.3°	+2.45
18	Petroleum Refinery—South Central	10,000	117.0	85.0	76.0	+0.75°	+7.4
19	Generating Station—Mid-Central	26,000	98.0	85.0	75.0	+0.83°	+8.1
20	Generating Station—South Central	61,000	103.5	88.0	78.0	−0.24°	−1.8
21	Air Conditioning—North Central	5,850	99.0	89.0	80.0	+0.8°	+8.7

*Conducted in accordance with procedure specified by ASME Power Test Code, recognized standard for measurement of cooling tower capability.

NOTES: 1. + indicates lower cold water temperature than specified; — indicates higher cold water temperature than specified. 2. Test results adjusted to specified conditions. 3. CTI observer present during test.

Write for "TEST YOUR TOWER"

A revised edition of this technical publication details the Marley method of tower testing; will enable you to know the capability of your tower. Write direct or ask your nearby Marley engineer for copies for your engineering staff.

THE MARLEY COMPANY ● KANSAS CITY MISSOURI

For more data circle 517 on Post Card

Current Catalogs

Instruments and Controls

101 Custom Control Systems—Coordinated control systems for process control, power plant control, machine control and motor control are illustrated and described by Electro-Mech Corp. in 8-pp Bulletin 203.

102 Selsyn Systems — Bulletin GEA-7218, 6 pp, details indicating and remote control applications of selsyn monitoring systems of General Electric Co. Lists indicator arrangements available. Explains use of cam-operated limit switch as an automatic feedback control. Provides specification tables, dimensional diagrams.

103 Definite Purpose Controls — Eight-pp Bulletin GEA-7316 describes General Electric Co.'s definite purpose contactors and starters for air conditioning and refrigeration. Outline drawings and dimensions are included along with load data, coil data, outline numbers, wiring diagrams, current ratings.

104 Temperature Controls — Brief descriptions and specifications for 17 temperature controls are given by Fenwal Inc. in 8-pp Catalog MC-203. Covers Thermoswitch units, miniaturized local controls, fire and overheat detection models, snap action controls, and electronic controllers.

105 Combustion Control Systems —Introduced in 32-pp Bulletin 1001 by Reliance Instrument Div., Electro-Mech Corp., is the systems engineering approach to combustion control. Selection of electronic equipment and components with regard to overall application requirements of system, of boiler and burner equipment and fuel conditions is detailed and typical control systems are described.

106 Electronic Combustion Controls — Twenty-pp Bulletin 1002, of Reliance Instrument Div., Electro-Mech Corp., describes electronic combustion controls, including oxygen analyzers, flow meters, draft gages, control valving, interlock switches and flame safeguard equipment. Factors to be considered in selecting equipment and components are covered.

107 Pyrometer Indicator—In Catalog 64-1, Thermo Electric Co., Inc., describes the Minimite, a portable, potentiometer type pyrometer indicator. Includes specifications, application information, data on available accessories. Photos show construction details, ease of maintenance.

108 Automation System—Bulletin G-2500, 16 pp, issued by Reliance Electric and Engineering Co., explains how drive speeds of machines and processes can be automatically controlled and regulated by simple pneumatic instrumentation. Applications in controlling liquid level, line pressure, process temperature, constant flow, seam pressure and motor loading illustrated.

109 For Speed Measurement—Bulletin GEZ-3251, 12 pp, describes General Electric Co.'s a-c and d-c tachometer generators and indicators. Relates information on instruments' applications, calibration, accuracy, and method of selection. Specifications, schematics and photos of measurement systems included.

Valves, Pipe, Fittings

110 Ball Valves — Comprehensive information on manual and pneumatically operated ball valves in sizes from ¼ through 12 in. is given in 32-pp Catalog 1200 by Hills-McCanna Co. Includes diagrams illustrating design features, dimensions and weights, material specifications, and pressure-temperature rating charts.

111 Solenoid Valves—High pressure solenoid valves for precise control of hydraulic systems are described by Waterman Hydraulics Corp. in 20-pp. Catalog 2002. Design and performance features are detailed and dimensional diagrams and pressure drop charts included.

112 Valve Flow Characteristics—Two methods for determining flow characteristics of Rockwell-Nordstrom valves are described by Rockwell Mfg. Co. in 20-pp Bulletin V-602. Covers fundamental method of determining pressure drops for lubricated plug valves, as well as method of estimating pressure drop through Venturi type valves.

113 Installing Pressure Pipe — Form TR-62A is a 24-pp installation guide for Transite pressure pipe. Offered by Johns-Manville Corp., covers handling and installation of the pipe from loading and unloading to assembly of pipe and couplings, cutting and machining, service connections, backfilling, testing, repairing. Includes data on site conditions.

114 Unions, Fittings — In this 16-pp illustrated catalog, Stockham Valves & Fittings Co. gives complete details on design, weight and dimensions of unions and union fittings. Also included are engineering specifications and information on prices.

Mechanical Power Transmission

115 Variable Speed Drive—A self-contained variable speed drive, including a-c motor, variable pitch pulleys, and gear reduction unit in a single housing, is featured in 88-pp Catalog G-100 by Reliance Electric & Engineering Co. Dimension diagrams and charts for over 100 different assemblies are included, also rating tables and output speeds.

116 Adjustable Speed for Pumping —Rectiflow and MagnaFlow adjustable speed drives for pumping applications are discussed by Westinghouse Electric Corp. in 8-pp Bulletin 5560, an application data booklet. Provides a drive selector guide for water treatment stations, constant pressure pumping systems, industrial process, sewage disposal stations, others. Includes efficiency curves, mechanical features.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 91 and 92.

117 For Range Drives — Bulletin F-2028, U. S. Electrical Motors, Inc., describes application of U. S. Varidyne a-c controlled speed systems to range drives. Tells how frequency-control of speeds in a-c squirrel cage motors permits motors to start, stop, accelerate to full speed and accept speed adjustment while running. Provides schematics of applications on range drives for both tension control and tensionless operation.

118 Geared Flexible Coupling — Described in 6-pp Folder 2975 of Link Belt Co. is a low cost geared flexible coupling for electric motor applications. Couplings described are designed specifically for use as motor couplings for transmitting power to pumps, compressors, generators, speed reducers and similar units.

Electrical

120 Motor Selection Simplified — Twelve-pp Bulletin B-2515, illustrated in color, presents Duty Master a-c motors from 1 to 2000 hp, of Reliance Electric & Engineering Co. Product features of each motor are outlined and explained for easy selection. Also provided is a detailed description of company's production facilities.

121 Torque Motors — In Bulletin 208A, The Ohio Electric Mfg. Co. provides speed-torque curves, duty specifications, dimensions and ratings on torque motors. Those covered range from 1.5 to 96 oz-ft; 110 to 550 v a-c, one, two and three phase, and 115 and 230 v d-c. The Ohio Electric Mfg. Co.

122 Power Centers — Sixteen-pp Bulletin GET-3041, General Electric Co., gives application data on Cabinetrol power centers utilizing standard components. Gives specifications on squirrel cage, synchronous-motor, wound-rotor-motor and d-c motor combination starters, as well as incoming line breakers, secondary breakers and

feeder circuit breakers. Low-voltage unit substations are also described.

123 Distribution Centers—Bulletin GEA-7222, 24 pp, describes General Electric Co.'s integral distribution centers with liquid-filled transformers, 112½ kva and above (oil or Pyranol), and dry-type transformers, 300 kva and above. Provides data on incoming sections, transformer sections, and low-voltage equipment. Includes descriptions, installation details, weights and dimensions tables.

124 Distribution Transformers — Operating and maintenance benefits of Endur-All distribution transformers are detailed by Allis-Chalmers Mfg. Co. in 8-pp Bulletin 61B9943. Stresses advantages of higher overload capabilities.

125 Dry-Type Transformer—Comprehensive information on single phase, three phase and phase changer dry type transformers is presented in 36-pp Bulletin 102-261. Includes transformer photos, wiring diagrams, specifications and prices. Booklet is offered by Atlantic Transformer Co.

126 Reduced Voltage Controls—In 16-pp Publication 2100-PRD-202, Electric Machinery Mfg. Co. describes magnetic, low voltage, synchronous motor controls using auto-transformer or part winding starting. Shows dimensions and weights and details of construction. Controls covered are particularly suited where across-the-line starting is difficult.

127 Distribution Regulators — Information about overhead-type, single-phase distribution voltage regulators is presented by Line Material Industries, McGraw-Edison Co. in 20-pp Bulletin RV2. Includes application information, design and operating features, accessory data, and dimensions.

128 Load Control Systems—Bulletin GET-2916B describes General Electric Co.'s load control systems for industrial plants which generate all or part of their electrical requirements. Describes tie-line and frequency control, reactive power control and power limiting control, and includes schematics.

129 Safety Switch — A switch for protecting machines, equipment and processes against damage from stoppage or reduced speed is described and illustrated in Bulletin MS-3 offered by Fuller Co. Design, installation, operation, applications, photos and a cutaway drawing are included.

130 Magnetic Level Switches—Mobrey magnetic switches for the petroleum industry are presented in Brochure M.212/5612 by Bestobell (Canada) Ltd. Covers construction, operation and electrical characteristics of standard, interface, low- and high-temperature models.

131 Insulated Cable—Latest information on cables insulated with a butyl-base high voltage insulation for extreme resistance to ozone, heat and moisture is available in 48-pp Reference Manual 1131, The Okonite Co. Contains data on current carrying capacities, dimensions and design.

132 Epoxy Insulation Selector — Systems selector for epoxy insulation (Bulletin E-100) by Hysol Corp. shows properties of selected electrical insulating compounds. Contains data on insulation selection, gives handling characteristics and physical and electrical properties.

133 Insulation Testers—Twelve-pp Bulletin 21-45-24, of James G. Biddle Co., describes new and improved models of Meg type Megger insulation testers. These are in the 500- and 1000-v class with extended sensitivities to 10,000 megohms in the 1000-v instruments. Includes discussion of advantages of insulation resistance testing in electrical maintenance and tells how to select proper instrument.

134 Grounding Facts—Recent information on NEC requirements most likely to affect installation and operation of portable electric tools and equipment is presented by The Arrow-Hart & Hegemen Electric Co. in this revised 8-pp booklet. Describes typical grounding installations, contains diagrams of construction of grounding terminals and U-shaped grounding contacts. Pictures receptacles, caps and connections, and includes configuration and voltage chart covering 18 types of grounding devices.

Heating

135 Heavy-Duty Heaters—This 12-pp brochure contains descriptions, technical data and application photos on combination oil-gas industrial heat of Lennox Industries, Inc. Blower performance charts are included for each unit, from 280,000 to 1 million Btuh, as well as dimensions, air handling capacities, heat exchanger area, motor horsepowers, additive cooling capacities and plumbing data. Diagrams show possible arrangements.

136 Indirect-Fired Heaters—Eight-pp Bulletin 400 describes Brown Fintube Co.'s indirect-fired heaters for gases, vapors, and liquids. Advantages of design and operation are detailed and general specifications and capacities listed, along with data on auxiliary equipment.

137 Storage Tank Heaters — Sixteen-pp Catalog 602, on hot water storage tank heaters of Old Dominion Iron & Steel Corp., describes steel, "Odis coat" cement lined, copper lined and solid copper-silicon tanks, as well as heating elements for them. Provides piping diagrams, engineering data and heating capacity charts.

Water Conditioning

138 Water Conditioning—Automatic dispensers and water conditioning chemicals for preventive maintenance are described by Stiles-Karlsonite Corp. in this 24-pp bulletin. Discusses common water problems, preventive maintenance for cooling towers and evaporative condensers, and includes testing instructions, a "what to do" table for treating specific conditions.

139 For Boiler Troubleshooters — Bulletin CS 113 of Ionac Chemical Co. is a maintenance checklist covering boiler and cooling water system troubles and recommended treatments. Lists 23 common troubles arising from water and fuel contaminants and other causes. Gives diagnosis of causes for scaling, corrosion, foaming, etc.

Construction

141 Non-Shrink Mortar—Value of non-shrink mortar in new construction is discussed in Bulletin E-38 by The Master Builders Co. Operations covered include waterproofing walls and joints, grouting building columns, machinery and anchor bolts, caulking sewer pipe joints, patching defects in concrete, and setting floor brick and quarry tile.

142 Grating, Treads — Safe load tables, specifying and fastening data, and application photos on grating and treads are provided in 24-pp Bulletin 2527-R of Blaw-Knox Co. Also describes Ponbake, a baked-on epon paint process used. Types and spacings and bearing bar surfaces of electroforged steel grating and treads are highlighted, along with rectangular and U type in interlocked aluminum grating.

Engines, Turbines

143 New Look in Gas Engines — Bulletin 205 discusses two-cycle gas engines, emphasizing performance characteristics in variable-speed, variable-load applications. Constant pressure turbocharging and ignition timing control, and advantages of each are explained; performance curves provided. Bulletin is offered by Clark Bros. Co., Dresser Industries, Inc.

144 Mechanical Drive Turbines — Single-valve multi-stage mechanical drive turbines are described by General Electric Co. in Bulletin GEA-7152. These turbines come with three inlet valve sizes for application to various uses and flow requirements, condensing and non-condensing, with wide choice of exhaust orientations. Tells how, in some applications, an 8-in. valve size permits use of a single valve unit at substantial savings.

Materials Handling

145 Sling Chains—In 20-pp Catalog S-261, Campbell Chain Co. features Cam-alloy, wrought iron and high-test steel sling chains. Contains a section on sentry sling chains and bell-type magnet assembly. Tables of specifications, glossary of chain terms and industry coding symbols included.

146 The Reel Story—Aero Motive Mfg. Co.'s industrial reels from 1½-lb size to those capable of retracting a mile of cable are described in Form DC. Covers cord and cable reels for many applications, including motor driven reels, explosion proof units, balance reels.

147 Guide to Bucket Elevators — Catalog 55, of Webster Mfg., Inc., is an 84-pp manual designed to simplify selection and application of bucket

more Current Catalogs page 91

Hall Industrial Water Report

VOLUME 9 JUNE 1961 NUMBER 3

Anything can happen

Or almost anything—in industrial plant water systems. Gravy gets into condensate, ammonia into cooling water, fuel oil into boiler feedwater, plating wastes into drinking water.

Serious trouble is always a potential result—blistered boiler tubes, heat exchanger shut-downs, wrecked turbines. But operating men are alert and usually notice that something has gone wrong. Working with them, the Hall field engineer, through training and experience, can quickly trace contamination to the source and recommend corrective measures, both immediate and long term.

Similarly, he can help you with all your water problems—boiler water, cooling water, service water, process and waste water.

Trouble can be beautiful

This crystalline deposit was beautiful to look at but caused plenty of trouble.

Deposition of calcium carbonate is quite normal when hard limestone water (temporary hardness) is heated. In this case, the plant's hot water piping was renewed *twice* in six years because of plugging. A water softener was the simple but complete answer to this particular problem.

Why high silica?

Excessively high boiler water silica concentration at an Eastern paper mill was the signal that something had gone wrong. Blowdown was increased in an attempt to reduce it and the call went out for Hall field engineer P. D. Cardillo.

What was the source of the silica? Cardillo found the concentration in the make-up water to be normal. Then the mill condensate was checked. It contained 10 ppm which could be accounted for only by contamination.

Continued checking of condensate samples from various sources finally narrowed the search to the hardwood mill. Here a leak was found in a heat exchanger in which bleach water containing 35 ppm silica was being heated. The silica was going back to the boiler in the heat exchanger condensate.

Training and experience, plus a silica test kit, quickly led Cardillo to the trouble point.

Unusual feed pump failure

When a food product plant in the east started the perfectly normal procedure of feeding sodium sulfite to the boiler feedwater to control corrosion, the unexpected happened. For some unknown reason, feed pump impellers began to fail rapidly from erosion.

The pump manufacturer was as thoroughly puzzled as the plant engineer who finally described the problem to Hall field engineer R. A. Beardsley. Following his own study, Beardsley recommended that the pump suction line be replaced. He reasoned that heavy, old corrosion products in the pipe were being loosened by the change in water conditions. Being abrasive they were accelerating wear, accounting for the failure of the pump impellers.

The pipe was replaced. With no repetition of trouble after more than a year of operation, Beardsley's reasoning was proved to be correct.

Poor samples

The operators in an oil refinery suddenly ran into trouble with the hot lime—hot zeolite softener. For no apparent reason, hardness of the effluent jumped to 2 gpg and repeated regenerations of the zeolite failed to produce any change.

Oil seepage around the manhole to the de-aerating section of the hot process softener indicated the possibility of oil fouling of the ion exchange resin. It was removed from the tank, washed with naphtha and put back. Hardness of treated water was still 2 gpg.

Although he felt that the resin should be replaced, the plant engineer called Hall field engineer D. C. Altenburger for a final check. Unconvinced that the resin was at fault, Altenburger, in five minutes, spotted what was wrong. Someone had opened a valve in the piping connecting the inlet and outlet pressure gauges on the hot zeolite softener. Samples taken from the connecting piping accordingly were a mixture of both hard and soft water. Closing the valve solved the only real problem—by providing true samples.

For your copy of 24-page brochure describing the many ways industry can use Hall Laboratories industrial water consulting services, write on your letterhead to:

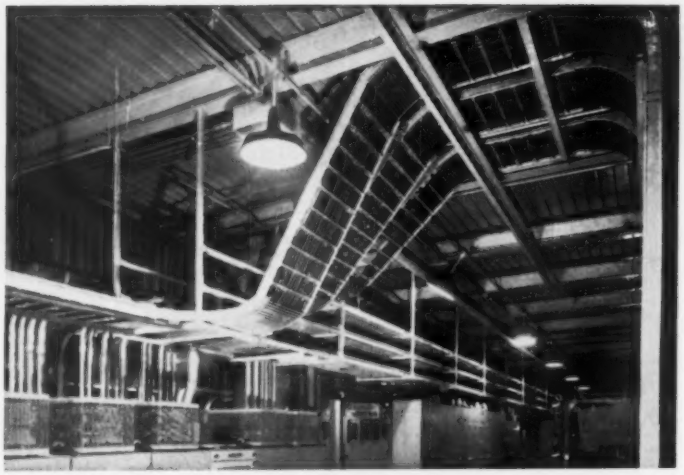
HALL LABORATORIES
HAGAN CENTER, PITTSBURGH 30, PA.
Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

DIVISION OF **HAGAN** CHEMICALS & CONTROLS, INC.

For more data circle 518 on Post Card

how INLAND STEEL uses GLOBE INTERCHANGEABLE TRAYS

to support cables in their Indiana Harbor Plant



★ Engineered for Uniform Design and Easy Installation
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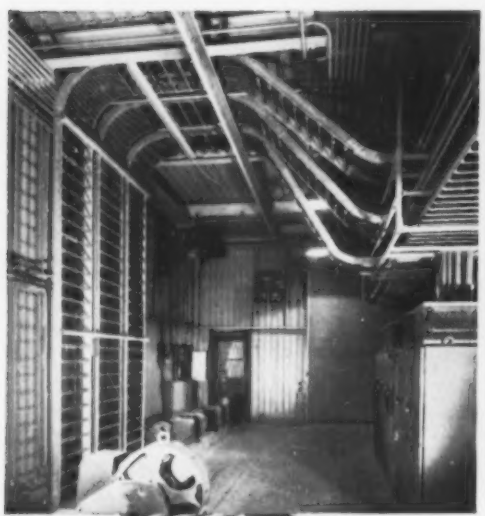
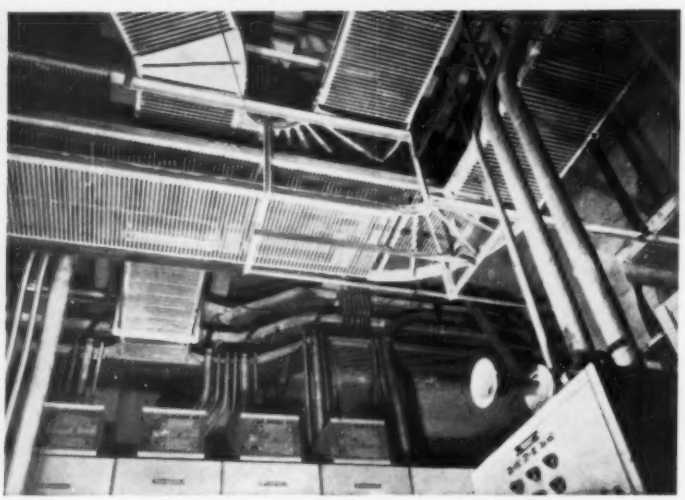
★ Complete Accessories for SPEEDIER Installation
★ Complete Interchangeability
★ No Sharp Edges to Damage Cables





Globe's two types of cable trays, one a ladder type and the other a basket type, to support cables, wiring and tubing have become increasingly popular because they can be used INTERCHANGEABLY at any given location depending on the type and weight of the cables to be suspended. The advantages of each type tray can be used to the fullest. Globetray, the ladder type, is intended for use where festooning is not a problem, while Cable-Strut, the basket type, is used for the support of communication wire, instrument tubing and control cables in automation applications.

These two cable trays have been thoroughly field tested in hundreds of large industrial installations, in new plant construction, in power plants and for power distribution in all types of manufacturing processes. Send for FREE catalog giving full information and installation techniques.

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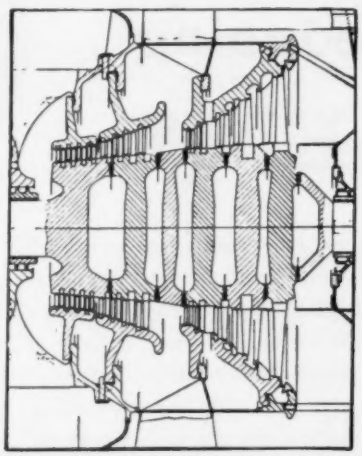
Welded sectional rotors for steam turbines

By N. K. Halsteen, Project Engineer, Brown Boveri Corp.

BROWN BOVERI

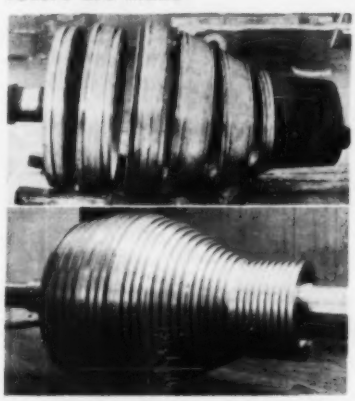
The manufacture of large, solid, one-piece rotors presents problems in detection and inspection of flaws, often resulting in the difficult choice of scrapping an expensive forging or completing the rotor with a "patch" or with an internal flaw whose effect in operation cannot be predicted with certainty. In use, the mass of a solid rotor also causes difficulty in maintaining tight shrink fits for the wheels and prevents uniform heat distribution for short start-up or shut-down schedules.

To avoid these difficulties, Brown Boveri developed a rotor made of forged discs and hollow, bell-shaped end sections welded together at the rims, forming a light, strong, rigid unit.



Cross-section of low-pressure stage showing welded segments of rotor shaft.

How Brown Boveri sectional rotors are made



Above: Sections of shaft ready for welding.

Below: The shaft after welding, heat-treatment and machining.

The rotor is assembled vertically on a turntable, the sections being centered by spigots. As the workpiece rotates past welding heads, the butting surfaces are welded. Welds are made at several points around the section at the same time—to prevent distortion. The welding is done automatically by the tungsten inert-gas process . . . providing homogeneous welds free of slag.

After a few layers of weld, the root is checked with gamma rays. If approved, the welding is completed.

After a final ultrasonic test, the welded area is given stress-relief heat treatment, with the rotor in vertical position. Machined rotors are tested at 40% overspeed before blading . . . also balanced statically and dynamically after blading.

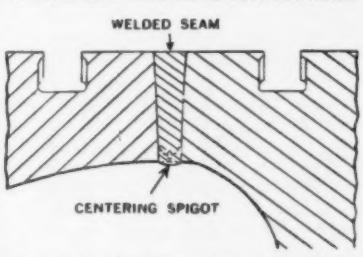
Advantages of sectional rotors

Because of the relatively small size of each section, forging conditions meet ideal metallurgical requirements. Inspection can be complete. Doubtful sections are scrapped without any attempt at "patching." Possible asymmetries resulting from forging are cancelled by the chance disposition of individual sections.

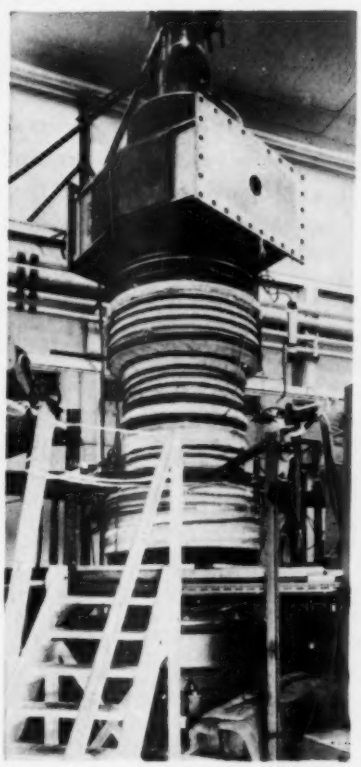
The stress-relieving procedure practically eliminates asymmetrical stresses.

The low mass of the rotor results in a favorable mass ratio between rotor and casing . . . with far less critical expansion differentials during sudden load changes or short start-up and shut-down schedules.

As evidence of its sound engineering. the Brown Boveri sectional rotor design has been used for over 30 years in several thousand rotors—and without a single explosion or other serious rotor failure.



Cross-section of weld seam. Note uniform thickness of rims at weld — for minimum thermal stresses.



Automatic welding of sections. Also shown are insulating blanket and induction heating cable for pre-heating before welding and stress-relief treatment after welding.

Other features of Brown Boveri steam turbines: an all-hydraulic governing system without rods, levers or mechanical joints subject to wear and resulting inaccuracies . . . and an unequalled reliability of service illustrated by many Brown Boveri turbines built 40 to 45 years ago and still in continuous operation.

BROWN BOVERI Brown Boveri Corp., Dept. PE6, 19 Rector Street, New York 6, N.Y. Agents in 27 U.S. cities

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PRESSURE REDUCING VALVE SELECTION CHART								
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SIZE—Inches	½–8"	½–1½"	2–4"	¾–6"	¾–6"	½–8"	½–1"	¼–½"
MAX. INITIAL PRES. PSI	200	250	250	250	250	250	250	300
MAX. REDUCED PRES. PSI	15	80	125	125	15	125	125	180
MIN. REDUCED PRES. PSI	1	5	5	15	2	5	2.5	5
STEAM SERVICE								
WATER SERVICE							*	
AIR SERVICE							*	
GAS SERVICE								
OIL SERVICE								
SINGLE SEATED								
DOUBLE SEATED								
SPRING LOADED DIAPHRAGM								
WEIGHT & LEVER								
CONTINUOUS SERVICE								
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*When specified, diaphragm must be changed from phosphor bronze to rubber.

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ATOMICS

A section of POWER ENGINEERING covering current and forthcoming developments in the field of Nuclear Power throughout the world

ANDREW W. KRAMER

Editor

Economic Prospects for Nuclear Power in New Countries

Nuclear energy is often regarded as offering a quick and easy road to industrialization for new and so-called backward countries of the world. That this is not true has become quite evident to those who have analyzed the economics of nuclear power development in terms of the various New States' resources. The article presented here is a condensed preprint of an article to appear in ATOMICS Quarterly. This article is based on a paper given by J. A. Jukes, Economic Advisor to the United Kingdom Atomic Energy Authority at the International Conference on "Science in the Advancement of New States," held in Rehovoth, Israel, in August 1960, and published in the United Kingdom Atomic Energy Authority's bulletin ATOM. It constitutes a most thorough analysis of the economics of nuclear power development against the background of the world's supplies and use of energy.

NUCLEAR POWER is not at present being produced anywhere in the world at competitive costs. Most of the nuclear stations now under construction are also unlikely to be fully competitive: They are primarily justified by the experience that will be gained through their construction and operation. However, fully competitive nuclear power stations should be built in some countries before the end of the present decade. It is, therefore, of interest to examine the likely characteristics of these stations.

Because of the long time required for development, the reactor type in this period is effectively limited to systems already developed beyond the experimental stage. Consequently, we can already predict that the first truly competitive nuclear power will be from reactors using graphite or water (including heavy water, possibly) as a moderator, and being net consumers of fissionable material.

It can also be predicted that these reactors will be of large size. The reason is simply that nuclear reactors show greater economies of scale than fossil-fueled stations. Figure 1 shows the capital costs per kw of different sizes of nuclear and conventional stations under present British conditions. (Editor's Note: U.S. costs are not essentially different.)

The gap between the nuclear and the conventional capital costs increases sharply as the size of the station decreases. Since capital costs form a large part of total nuclear power costs, the shape of these curves will be reflected also in the total power cost curves. It is for this reason that nuclear power is likely to be competitive first in the large sizes.

Similar curves for other countries and for other types of reactors will differ slightly, but their general shape and relationship to conventional costs will be roughly the same. During this decade we cannot expect that they will be competitive in sizes much below 100 to 150 Mw, except in special circumstances.

The bar chart in Fig. 2 shows the cost of power per kwh from a large station as compared under various conditions with a large modern coal-fired station. (The figures are partly based on a recent report by the Organization for European Economic Cooperation, OEEC.) The costs are divided into the main constituents: capital charges, fuel costs, and other operating costs. Two costs for fossil fuels are shown, the lower cost representing the price of coal for a generating station situated on a low-cost coalfield and the higher a station away from the coalfields. The left-hand side shows 8 per cent capital charges and 75 per cent plant utilization; and the right-hand side 14 per cent capital charges and 50 per cent utilization.

The nuclear plants are expected to have high capital costs. The cost shown in the chart corresponds to $350 per kw. The latest station ordered in the British nuclear power program is expected to cost $308 per kw, but the cost will vary somewhat from place to place. Although fuel costs are only a small proportion of the total, they are by no means negligible. As capital charges form a high proportion of the total, the nuclear costs are adversely affected by taking higher capital charges and lower utilizations. Coal-fired stations are much less affected by these factors but are very dependent upon the delivered price of fuel.

In the example taken, the nuclear station would be just competitive on base load in high fossil-fuel cost areas and with low interest rates. It is not competitive at lower load

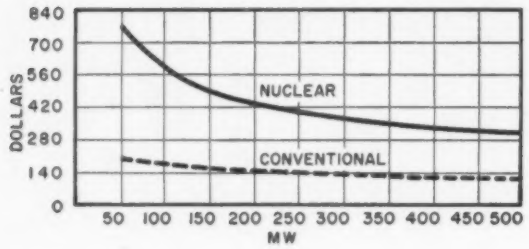


Fig. 1. Effects of economies of scale. Capital costs per kw

factors and when compared with cheaper fossil fuels, or in countries having high capital charges. In Britain at high load factor and with low interest rates, but intermediate coal costs, it would not be quite competitive. And it would be still less likely to be competitive in the smaller sizes.

Immediate Prospects

The areas of the world where nuclear power is likely to be installed in this decade can be derived directly from this analysis of immediate prospects. Nuclear power will be used in advanced industrial countries that are short of cheap conventional fuel but have the capital resources to devote to the development of a new fuel. It will require a country with a large and growing demand for electricity and with integrated transmission and distribution networks.

There is one other reason for expecting the bulk of the nuclear capacity installed in this decade to occur in the advanced industrial countries. A nuclear reactor designed to be economic is unlikely to be a simple "black box" which can be switched on and off by any unskilled operator. It will be a complex technical device requiring a high degree of scientific and engineering skill both to construct and to operate efficiently. A simple automatic nuclear station is a possibility, but at present could only be constructed at greatly increased cost. Its primary use would thus be confined to military applications. We must therefore expect the early civilian nuclear power stations to make substantial calls on scientific resources. Advanced countries can meet these demands, but New States may well find their very scarce scientific resources would yield a bigger return in other directions.

In this decade the scope for nuclear power and the scale on which it is installed will therefore be strictly limited. Thereafter the position should gradually change. There should be a continuing reduction in the capital cost of the nuclear stations due to the normal process of engineering development, each successive design benefiting from the experience of the preceding designs. The real capital costs of different types of prime movers have always tended to fall steadily with time, and there is every reason to expect a similar process to take place at least as rapidly with nuclear stations. There should also be a steady reduction in the fuel costs of nuclear stations of any one type.

Figure 3 shows the forecast trends in the cost of power from new base load stations in Britain. The curve labeled "Magnox/AGR" is for nuclear stations, and its width reflects the uncertainty that is inevitable at present with forecasts of nuclear power costs. The curve labeled "coal" represents conventional stations and in this case its width reflects the differences in coal costs due to the transport of coal. The sharp fall in the curve for nuclear stations is taking place for a number of reasons. One of these is that, with improvements in technology, the size of the reactor is increasing and this itself leads to a fall in costs.

In addition to these cost reductions due to the normal development of a given type of reactor, there should from time to time be a major step forward into a different reactor technology. That is why a break is shown in the nuclear curve representing the stage at which the advanced gas-cooled reactor (AGR) starts to take over from the present type of station known as Magnox (because of the magnesium alloy canning material used). Beyond the time-scale shown in Fig. 3, there are likely to be other steps—due, for example, to the use of breeder, or near-breeder reactors.

Experimental Fast Breeder Reactors are operating in the United States, United Kingdom, and in the USSR. Larger versions are already being planned. The expectation is that these reactors, when fully developed, will have capital costs comparable with or better than the best thermal reactors; that they will have high thermal efficiencies as the result of operating at high temperatures, and that they will breed more fissionable fuel material than they consume and will have low fuel costs. To achieve these objectives intensive development will be required involving thousands of man-years of scientific and engineering effort. But when this system comes into use—probably in the 1970's—there is likely to be a further step-down in costs.

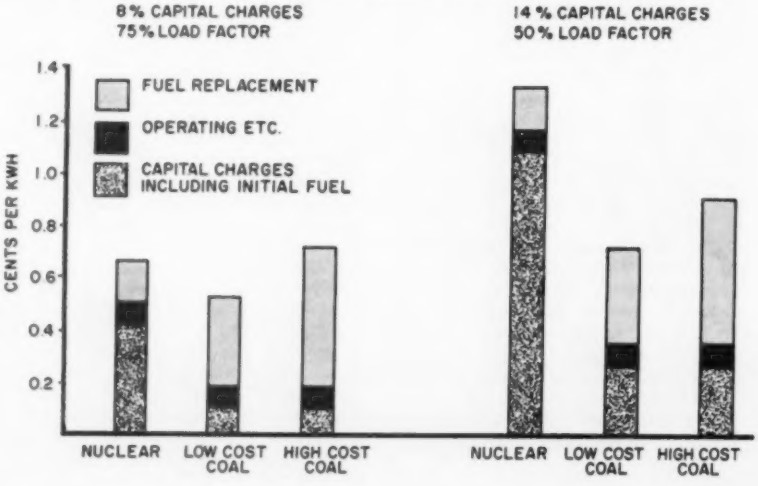
The High-Temperature Gas-Cooled reactor is in a similar category. Although it is not expected to be a breeder, its conversion ratio will be so near unity that the replacement fuel costs should be small. Here again experimental breeders are being developed in various countries.

There may be other similar *steps* in the development process. At some time in the future, thermonuclear reactions may provide an economic source of power, but at present it is impossible to forecast when this will be and what the economic characteristics of a thermonuclear station will be like. We must therefore leave this possibility on one side.

The coal curve in Fig. 3 shows estimates for the trend in the cost of power from conventional steam stations. This is mainly dependent on the cost of the fuel itself, and this is the biggest uncertainty with which we have to deal.

Historically the real cost of coal has tended to rise. As it is an ex-

Fig. 2. Effect of variations of capital charges and load factor



tractive industry which uses up the easily mined resources first, the industry is bound to be faced with progressively harder conditions, and these will force up costs in the end. This, however, does not necessarily mean that real costs will rise over a period of decades. Rapid technical advances may offset, or more than offset, the long-term trend. The same is broadly true of oil. Moreover, the cost of both fuels will be critically affected by the balance of supply and demand. In the last few years the balance has moved in favor of the consumer and prices have tended to fall. This short-term trend, aided by rapid technical progress, could go on for quite a number of years.

But now let us look at the longer term energy situation. Figure 4 shows on a logarithmic scale the growth of world energy consumption from 1900 to 1958 and various projections over the next 40 years. The lowest projection only corresponds to the minimum expected increase of population. This would imply no increase in fuel consumption per head, and we should dismiss it.

The middle two projections show what would be required if energy demand increased at the same rate as it has since the boom year 1929, the upper projection making an allowance for a number of large New States, such as China and India, to increase at a more rapid pace. This gives an energy consumption of 17 billion tons of coal in 2000, or four times that of today. The top line merely projects the rate of growth in world energy demand that actually occurred between 1950 and 1958.

Although it is difficult to forecast the trend of costs of fossil fuels in the next decade or two, the long term forces of greatly expanded requirements, Fig. 4, must exert an upward pressure on costs, whatever the size of the reserves.

Many New States have insufficient reserves of energy to support a major program of industrialization and expansion and are therefore looking to nuclear energy as a means of meeting their potential requirements. In the long term they are undoubtedly right, but the important question is one of timing. At what stage in their development will they be able to make use of nuclear energy with advantage?

W. W. Rostow, in his "The Stages of Economic Growth,"* has divided the economic growth of countries emerging from the traditional form of society into four stages. The first stage is called the Traditional and covers the period when conditions for the take-off into economic growth are established by political and social changes. The second stage is called the Take-off, a short period

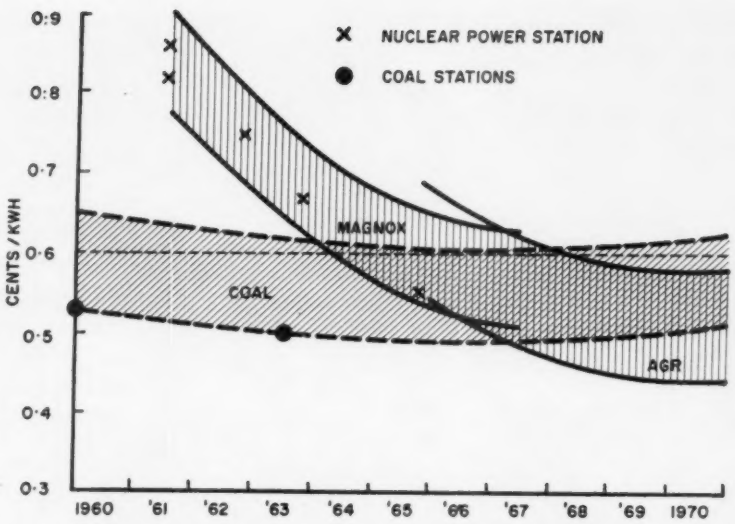


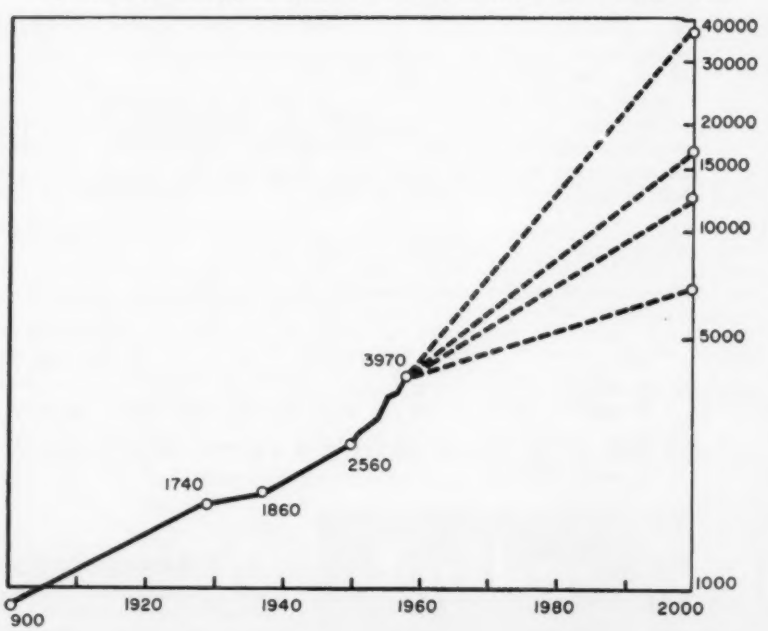
Fig. 3. Costs of base load generation at new stations

of perhaps two decades during which rapid growth sets in, usually based on one or two major industries. It is characterized by a big increase in the annual rate of net investment, through which the economy begins to grow rapidly and the growth becomes self generating. The third stage — which Rostow calls the Drive to Maturity — is one of continued, though somewhat slower, growth during which a diversification of industry takes place. The final stage—High Mass Consumption—is that in which the products of economic growth are used to provide high standards of living throughout the economy. New States, in the economic sense, are those near Take-off.

Figure 5 is a scatter diagram showing the present consumption per head of electricity in a considerable number of countries. The actual consumption in 1958 is shown on the vertical logarithmic scale. The horizontal axis shows the percentage by which 1958 consumption per head exceeded that in 1948—it is a measure of the rate of growth.

The four areas into which this chart is divided contain countries in roughly the same stage of growth as in Rostow's analysis. The bottom left-hand area contains countries that have not yet reached the eco-

Fig. 4. World energy consumption. Million metric tons coal equivalent



*Published by Cambridge Univ. Press, 1960.

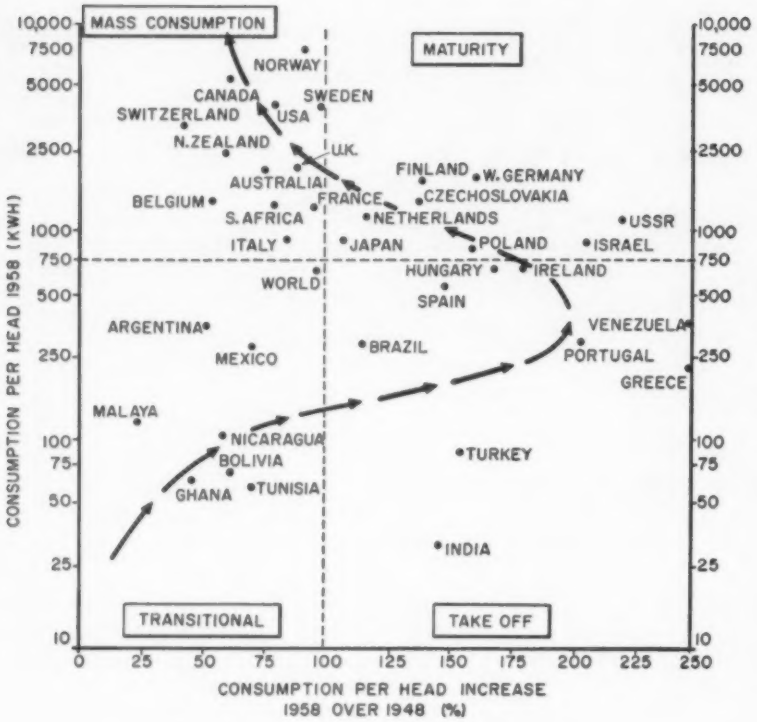


Fig. 5. The growth of electricity demand

nomic "Take-off" stage. These countries have low energy consumption and a slow rate of growth — a doubling of demand every 15 to 20 years.

The bottom right-hand area shows countries which are at the Take-off. Their consumption is still low, but their doubling rates are high with consumption doubling every 5 to 7 years. In the top right-hand area are the countries which are in the Drive to Maturity stage. Their consumption is greater than the world average, but their rate of growth is in general more moderate than at Take-off. Finally, in the top left-hand area we have the countries with high mass consumption. Here consumption is 5 to 10 times the world average, but the rate of growth has fallen to a doubling time of ten or more years.

Countries tend therefore to move along a path represented by the arrows during successive stages of industrialization and growth. The countries at Take-off, despite a high rate of growth in electricity consumption, still have low consumption per head; therefore, they are not the most likely countries for the installation of nuclear power. There may be, of course, some individual cases in the New States where there are local concentrations of demand and where large nuclear power stations can be employed. There may also be some special uses; for instance a nuclear reactor may be particularly useful in an arid area in providing a combination electric power plant and water distillation plant.

Nuclear power will, however, become of much more far-reaching importance as the New States reach maturity. Then, in 10 to 20 years' time, their consumption will have increased five times or more, and concentrations of demand will enable full use to be taken of nuclear power.

The immediate prospects for nuclear power in New States are therefore limited to a few special cases. New States, however, need not find this prospect discouraging. There is no need to rush into this new technology and so consume scarce scientific manpower and scarce capital; this probably can be used more effectively in developing the over-all economy. END

IMPORTANT NOTICE

Beginning in July 1961, ATOMICS will appear as a separate magazine, to be published quarterly, in July, October, January, and April. This new publishing plan will greatly expand ATOMICS' coverage of nuclear energy developments, but the new magazine will continue the policy of presenting information about nuclear energy development on a level that can be understood by engineers and others in industry who are not specially trained in nuclear science. ATOMICS will be devoted to all aspects of nuclear science and will cover development in the nuclear field both in the U.S. and abroad.

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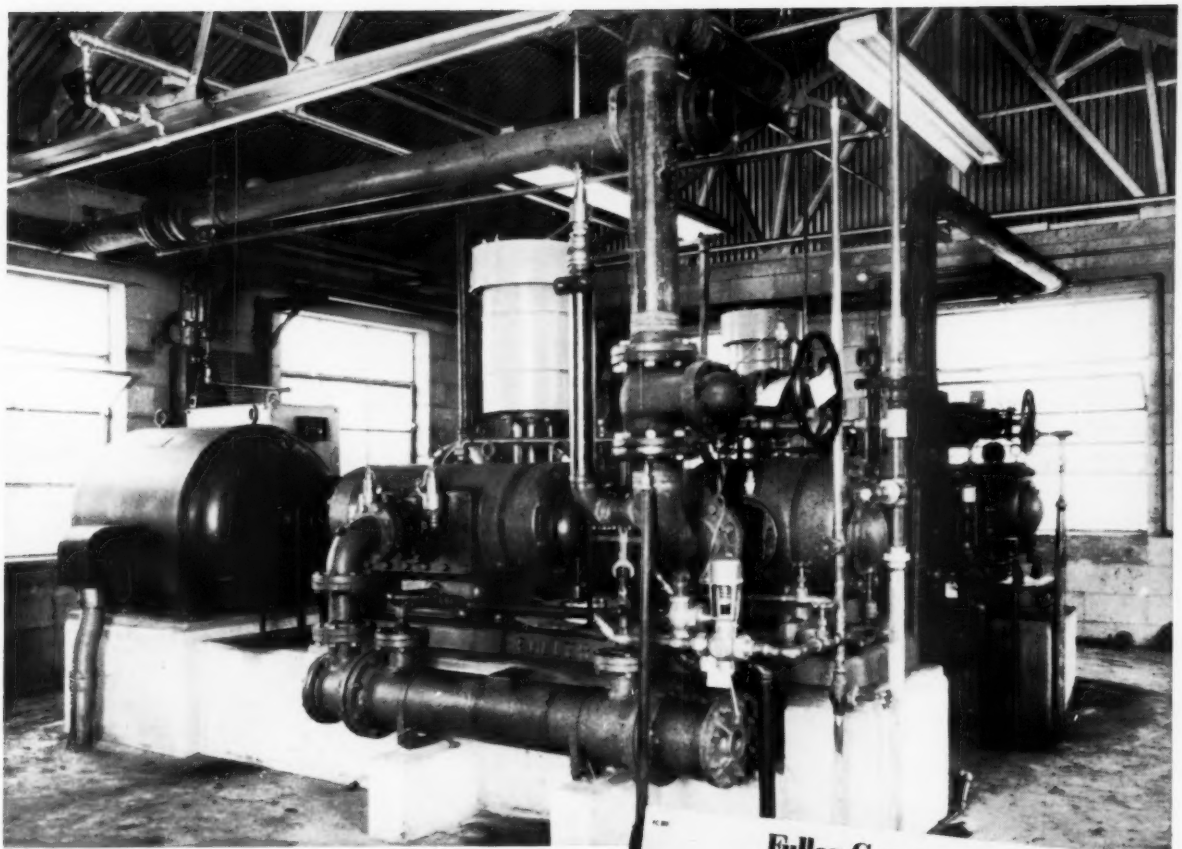

Two C135/135H Fuller Rotary Compressors at the Herbrand Division of the Bingham-Herbrand Corp., Fremont, Ohio, leading manufacturer of forged mechanics' hand tools and steel forgings for the automotive industry. Each compressor is rated 680 cfm, atmosphere to 100/110 psig., at 690 RPM.

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So satisfactory was the performance of its first Fuller Rotary Compressor, installed in 1956, that Herbrand Division installed another like it 3½ years later.

When the older unit was inspected after four years operation, no replacement of parts was necessary. After installation of a new gasket (cost $9.35)—to replace the one that had to be removed to make inspection—the compressor continues to add to its service record.

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Because Fuller Rotary Compressors are practically vibration-free, they can be installed without complicated or expensive foundations or structural modifications. They are simple and efficient, with no valves to leak, no seats to grind. Blades automatically compensate for wear. They have forced-feed lubrication to all parts within the cylinder. Rotor, bearings and blades are the only moving parts.

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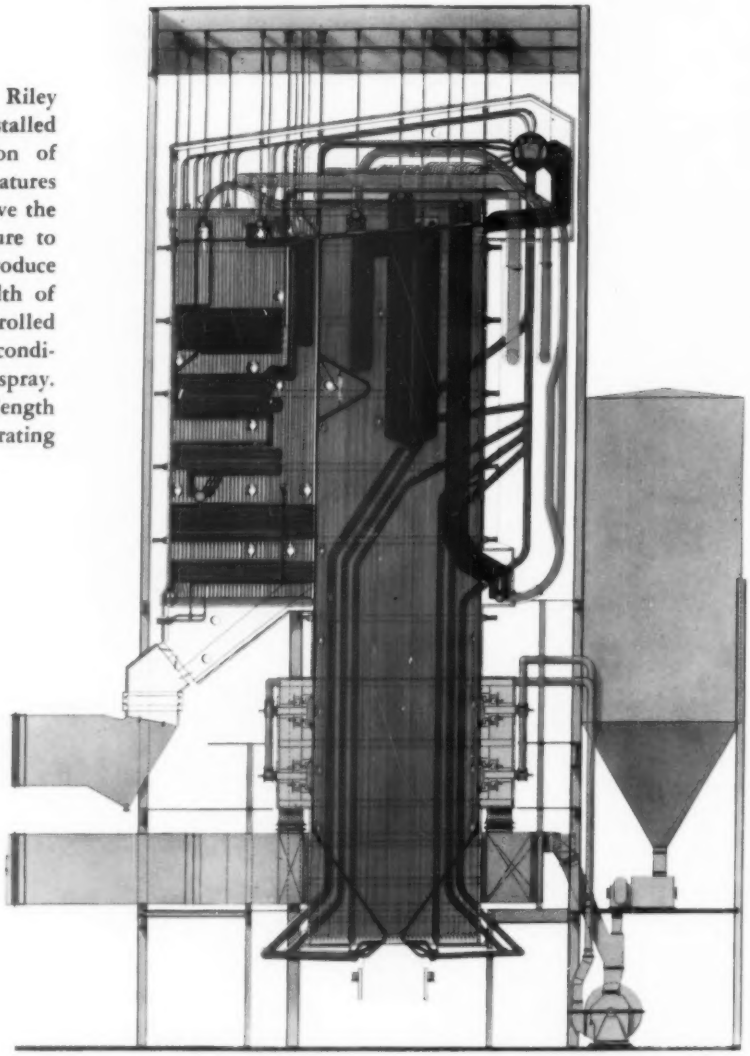
COMPLETE RILEY BOILER

for GOLDSBORO STEAM ELECTRIC STATION CAROLINA POWER & LIGHT COMPANY

The high pressure natural circulation Riley reheat steam generating unit soon to be installed at the Goldsboro Steam Electric Station of Carolina Power & Light Company features radiant superheater platens which will have the effect of reducing furnace gas temperature to correct levels at exit and also will produce uniform temperature across the full width of the furnace. Reheater temperature is controlled by dampers without spray under normal conditions. Steam temperature is controlled by spray. Large downcomers spaced equally across length of drum provide uniform feed to generating tubes.

EBASCO SERVICES, INC.
Consulting Engineers



RILEY COAL FIRED BOILER for

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Unit No. 3
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- Capacity ..... 1,620,000 lbs/hr
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- 5-550 Riley Pulverizers
- 20 — Riley Burners Arranged for Opposed Firing in Single Furnace — 58 feet wide.

A careful survey of your plant by a qualified consulting engineer could show ways of making substantial savings in power costs.

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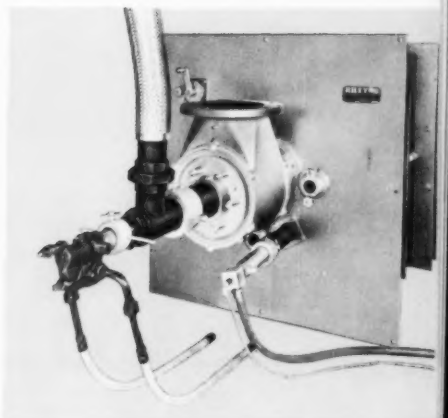
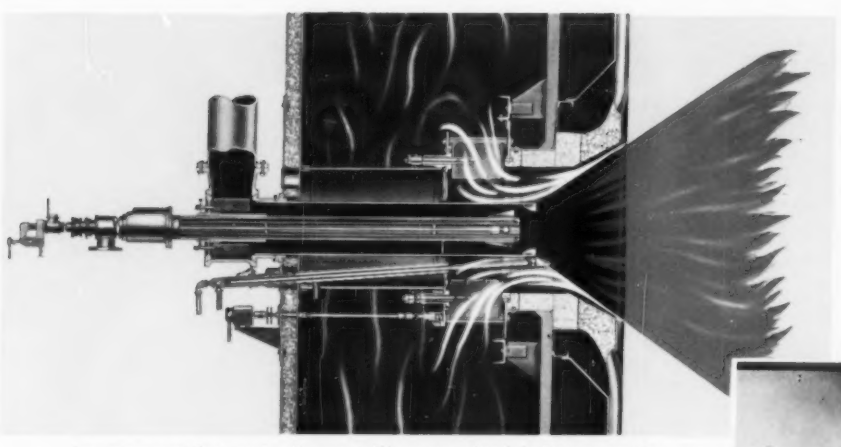
NEW RILEY BURNER HAS SIMPLIFIED FRONT PLATE — IDEAL FOR AUTOMATIC OPERATION

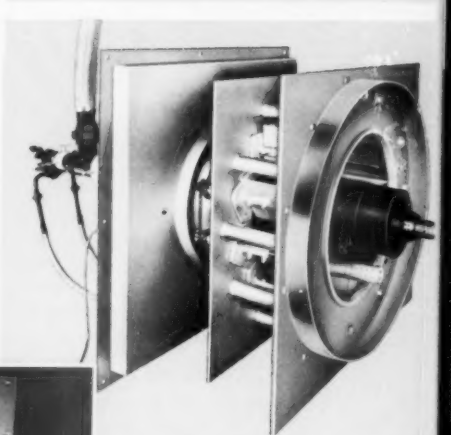
Some Operating Advantages:

- Mechanical moving parts move with boiler expansion—will not bind or jam.
- Vane control mechanism does not require lubrication.
- Automation with remote secondary air vane adjustment and indicators.
- Idle burners and ignitors well protected.
- Smooth, stable non pulsating flame thru load range.
- Non-plugging coal nozzle design.
- Turbulent mixing of primary air-coal secondary air.
- 180° rotation of vanes.

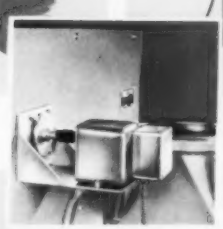




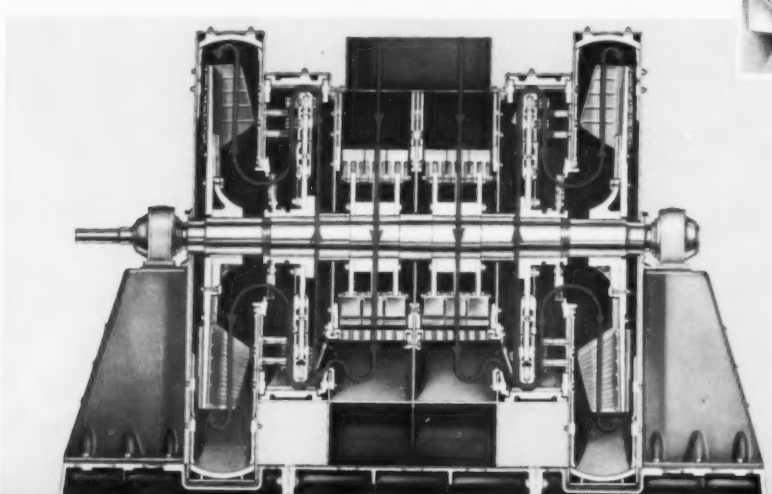
Arrangement for coal, oil, gas with pressurized boiler operation.



Above — Burner assembly for water-cooled burner throat.



Power unit for automated operation



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HOW YOU CAN SAVE MAINTENANCE...INCREASE OPERATIONAL TIME WITH YARWAY COLOR-PORT GAGES

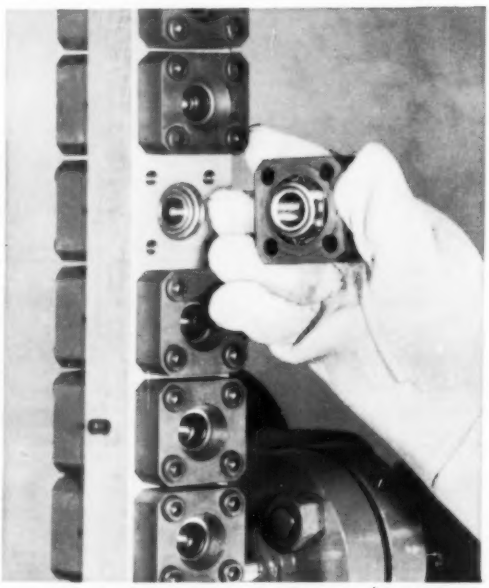
Two big problems confronting the operators of high pressure boilers—excessive maintenance and frequent downtime of water level gages—can be solved with new Yarway Color-Port Gages.

These Color-Port features will help you do the job:

- Patented spring loading of individual port covers, maintains proper pressure on glasses and gaskets at all times.
- Maintenance work can be done *with the gage in place.* NO TORQUE WRENCHES NEEDED!
- Individual "package" port assemblies (glass-mica-gasket) can be replaced in a few minutes.

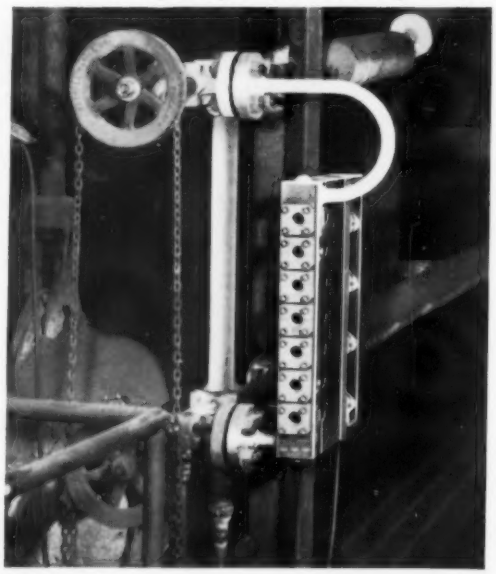
These benefits, PLUS brilliant two-color readings (water space shows green; steam space shows red), PLUS Yarway quality—make COLOR-PORT your best gage buy! 2 Series—1050 psi and 3000 psi.

Write for Yarway Bulletin WG-1815.

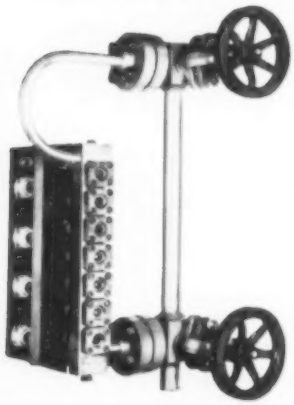


Servicing the Yarway Color-Port Gage is simple! Just remove 4 cap screws (no need for torque wrench), place new "package" assembly in cover, and replace cover assembly. A matter of two or three minutes.

Yarway Color-Port Gage installed on boiler at Alan Wood Steel Co. Leading industrial plants all over the country as well as many major utilities are among the hundreds of satisfied Color-Port Gage users.



NEW COMPACT DESIGN WITH "WELBLOC" VALVES SAVES INSTALLATION SPACE



New "Welbloc" valves on Yarway Color-Port Gages reduce installation space requirements up to 40%. All working parts of valves are easily accessible. Improved direct flow from boiler drum to gage, reduces temperature differential.

For more data circle 524 on Post Card

STATUS REPORT ON EXTRA-HIGH-VOLTAGE TRANSMISSION

In this first of a series of articles, Dr. Pier Abetti, of General Electric, discusses present state of EHV and predicts its future growth

DR. PIER A. ABETTI, who directed Project EHV, received the doctorate in electrical engineering from the University of Pisa, Italy, in 1945. He has also received degrees of MS and PhD in electrical engineering from Illinois Institute of Technology. He was honored as the Outstanding Young Electrical Engineer of 1953. In 1956 he was awarded the University of Liege's International Prize Montefiore, given every five years for outstanding original contributions to the art of electrical engineering.

SINCE THE FIRST electric power was generated by Edison in 1882, the demand for this vital commodity has doubled approximately every ten years. This exponential trend in the United States is clearly shown in Fig. 1, in which the total power output is plotted on a logarithmic scale. The dashed straight line corresponds to an annual increase of 6.9 per cent per year, or doubling every ten years.

It should be noted that the population increase in this country is about 1.7 per cent annually, and the increase in Gross National Product is three to four per cent annually. Thus, it is seen that the consumption of electric power increases about twice as fast as the over-all economy of the nation.

This trend has been essentially the same in all countries of the world, even in the less industrialized nations. In the Soviet Union, however, where the industrial output is rising rapidly, electric power consumption now increases at the rate of 11.3 per cent, or doubling every six years (Fig. 5). Similar high rates of growth are evident in many countries of Africa and Asia. There is no indication that this universal trend of increase in electric power consumption will slacken in the future. Thus, all over the world, electric utilities are faced with the necessity of generating, transmitting, and distributing twice as much power, six to ten years from now, as they are at present.

Required generation is obtained by building more and more steam-generating plants, which require considerable acreage for their sites and large amounts of cooling water, and therefore cannot always be located close to the load.

Another solution is to tap hitherto undeveloped hydroelectric resources (as is now being done in the Northwest, the West, and in Canada), which are normally several hundred miles from the load centers.

New sources of energy are being developed or investigated — for instance, nuclear power, wind power, and tidal power. Again, nuclear plants cannot always be located near the load because of cooling-water requirements and safety regulations of the Atomic Energy Commission.

Once the power is generated, it is then necessary to transmit to the centers of consumption, by means of high-voltage and extra-high-voltage transmission lines, over a distance which will vary according to the amount and type of generation, amount and type of load, and on the interconnections between adjacent power systems. In order to maintain the transmission capacity in step with the generating capacity and with the load, one possibility would be to *double every ten years the number of transmission lines of existing voltages.*

This solution is impractical for several reasons. First of all, rights-of-way for power lines are becoming more and more costly and more difficult to obtain. In some cases the right-of-way, say 200 feet wide, may cost more than the extra-high-voltage line built on it; from $50,000 to $100,000 per mile. In other cases rights-of-way are not available at all; for instance, near large cities, or in crowded mountain passes. In other cases, the public is not willing to grant easements, maintaining that the transmission lines spoil the landscape, are a safety hazard, cause radio and television interference and lower property values. (Yet the same public continues to demand an uninterrupted flow of electric power at bargain rates!)

Costly and time-consuming litigation ensues, and loss of good will from the public. Even when rights-of-way are available, doubling the number of lines every ten years would mean more than doubling the cost of transmission. This additional cost would be so high that it would be necessary for the power companies to raise their rates frequently. Thus another solution must be found.

The key to this impasse is to gradually increase the transmission voltage, in step with the increase of generation and of consumption. The reason is conceptually very simple. The *capability*, P, of a transmission line is roughly proportional to the *square of the voltage* used, E, then: $P = K_1E^2$ (see the table).

Transmission line *investment*, however, is roughly proportional to the *voltage*, and so are the operating costs (losses, maintenance, etc.). Consequently, if C is the total annual cost of a line (that is, the initial investment evaluated at a reasonable rate, such as 15 per cent annually, and the operating cost), then:

$$C = K_2E.$$

Consequently, the cost of transmitting an energy unit (kwh) over a unit of distance (mile) is:

$$\frac{C}{P} = \frac{K_2E}{K_1E^2} = K_3\frac{1}{E}$$

or proportional to the *inverse of the voltage*. Terminal equipment costs increase with voltage and therefore offset some of the advantages of higher voltages discussed above.

As the transmission distance increases, stability considerations become more and more important. In first approximation, the stability limit, P, of a transmission system, consisting of a sending-end hydro station and a receiving-end thermal station, both operating at the same voltage, E, is given by:

$$P = K_4\frac{E^2}{X}$$

where X is the total reactance of the system. This reactance is the sum of the reactances of the two terminal stations (which are independent of transmission distance) and of the line reactance, which is proportional to transmission distance. In order to increase the stability limit, it is necessary either to reduce the reactance (by using more and more lines in parallel, which is expensive and which requires more and more right-of-way), or to increase the voltage.

Right-of-way requirements increase approximately proportional to voltage because of the insulation distances required from the live conductors to the edges of the right-of-way, and between phases. Consequently, if R is the width of the right-of-way, then: $R = K_5E$, and the efficiency of right-of-way utilization (power transmitted per unit-

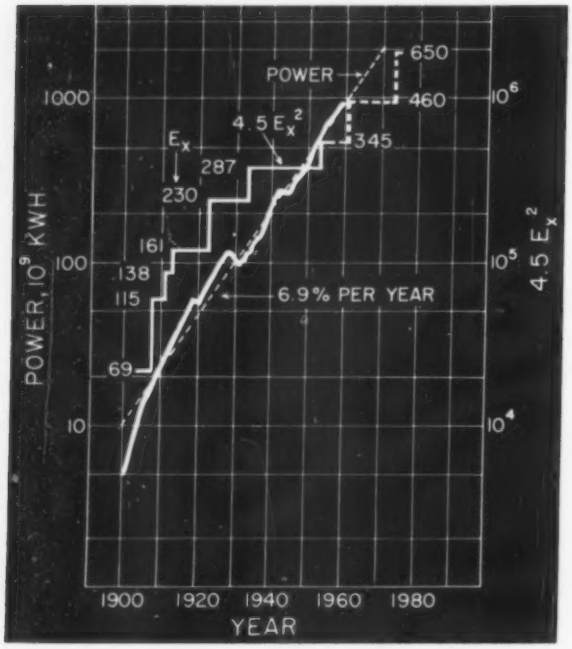


Fig. 1. U. S. power output and quantity $4.5E_X^2$ (E_X = highest rated system voltage in kv) vs. time

Surge Impedance Loadings (S.I.L.) Per Circuit for Representative Voltage Levels

KV	S.I.L. (MW) Single Conductor	Dual Conductors	Triple Conductors	Quadruple Conductors
115	33	41	—	—
138	48	60	—	—
161	65	81	—	—
230	132	165	—	—
287	206	258	—	—
345	297	372	425	455
400	400	500	570	615
460	530	662	756	815
500	625	780	890	960
690	—	1,480	1,700	1,820
750	—	1,750	2,000	2,150

Note: Surge impedance values assumed are 400, 320, 280, and 260 Ω for sngle, dual, triple, and quadruple conductors, respectively.

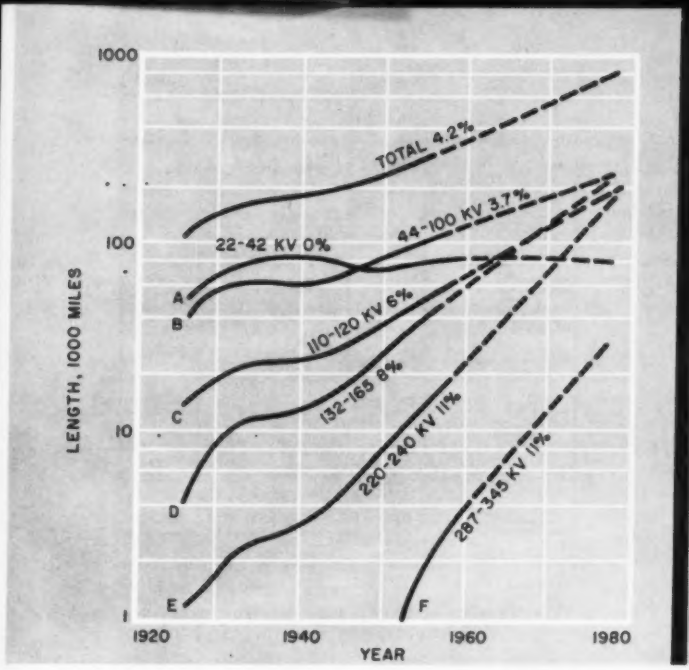


Fig. 2. Length of transmission lines in U.S. vs. time, by voltage ranges, and annual-increase trends

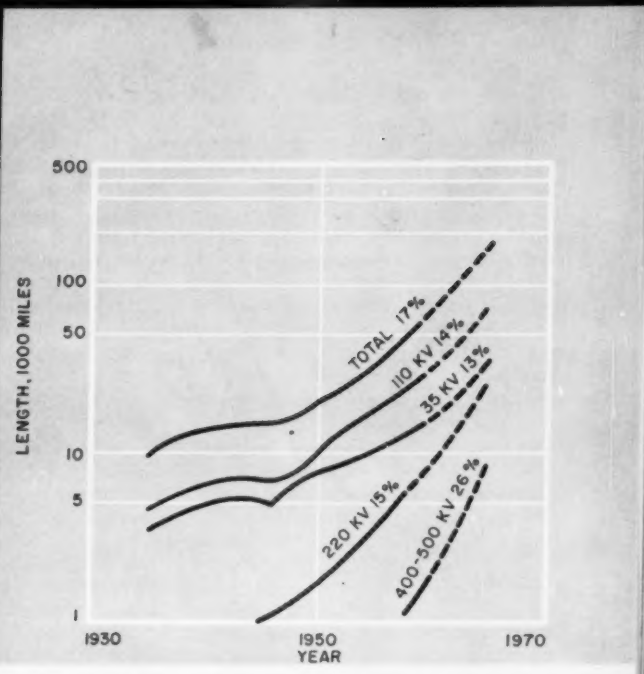


Fig. 3. Length of transmission lines in USSR vs. time, by voltage class, and annual-increase trends

width of right-of-way) is proportional to the transmission voltage; hence:

$$\frac{P}{R} = \frac{K_1 E^2}{K_5 E} = K_6 E.$$

Summarizing, it can be stated in general terms that: (1) For a constant amount of power to be transmitted, the economic voltage increases with the distance; (2) for a constant distance of transmission, the economic voltage increases with the amount of power to be transmitted; and (3) efficiency of right-of-way utilization is proportional to the voltage.

With these general considerations in mind, we will now discuss the progress of extra-high-voltage (EHV) power transmission in this country and abroad, its present status and future prospects, the problems which must be solved to transmit reliably and economically larger blocks of power over restricted rights-of-way, and the progress that is being made in meeting the nation's future requirements for electric power at reduced costs.

EARLY AMERICAN DEVELOPMENTS. The inauguration in 1882 of Edison's Pearl Street Station marks the origin of the American electric utility industry, but this was only a central generating station and a d-c distribution system. The *transmission* function was lacking in this pioneering development; transmission of a-c power (over several miles) dates from 1886, when a line was built in Italy to transmit 150 hp, over 17 miles, at 2000 volts. The real beginnings of the far-flung American electric systems of today were laid in the early California water power developments and in the accompanying requirements for the transmission of electric power over increasing distances, which necessarily required "high" voltages.

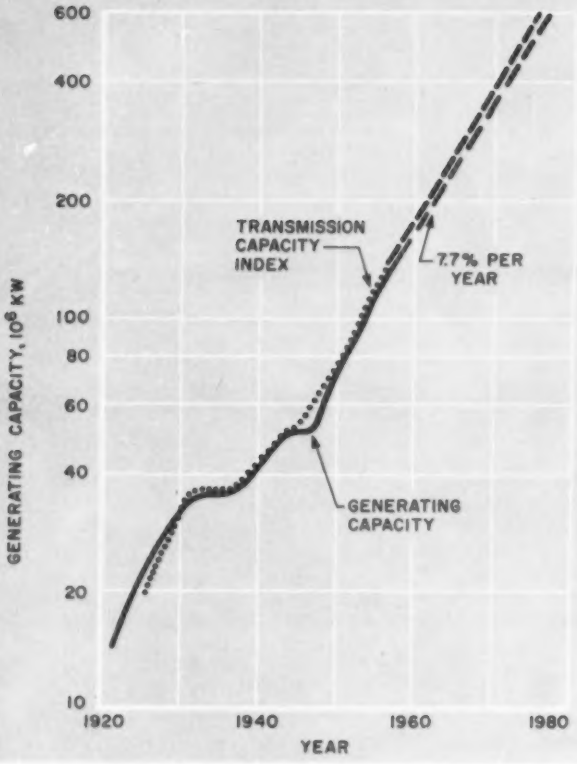
Thus, in 1892, 10 years after Pearl Street, 150 kw of single-phase, hydroelectric power in Southern California was stepped up and transmitted 14 miles, for the first time, at 10,000 volts. A further significant step, made possible in 1895 largely through the experimental and analytical work of early pioneers such as Professor Thomson and Dr. Steinmetz, was the Folsom 3000-kw hydro project, involving 11,000-volt, 3-phase transmission of 3000 kw, 22 miles to Sacramento. Some three years later, this voltage was tripled in a 33-kv, 3-phase line, 81-mile project also in California.

Next milestone, brought about by further hydro developments, was a 60-kv, 142-mile line from Colgate Hydro to Oakland, first energized at 40 kv in 1901 and raised to 60 kv in 1903. For several years, expansion continued at about this voltage level until the development of the *suspension insulator* by Hewlett and Buck, patented in 1907, provided a breakthrough to substantially higher levels. The first of these (in 1908) was the 100-kv, 155-mile line from Las Plumas to Oakland. Other projects during the same year included a 100-kv line in Colorado, limited by high altitude to 90-kv operation, and a 110-kv line in Michigan. From this point, developments moved rapidly, first in 1912 to the 140-kv, 125-mile line in Michigan, and in 1913 to the 150-kv, 240-mile line from Big Creek to Los Angeles.

Still under the stimulus of hydro developments, the next major step, one that was to establish a pattern for more than a decade, was the conversion of the 240-mile Big Creek-Los Angeles 150-kv line to 220 kv, on May 6, 1923. *This line, later increased nominally to 230 kv, was the first to be designated as "extra-high" voltage.* The 220-230-kv level was introduced in Europe at about the same time and remained the highest in the world for many years —until 1936 in the United States, and until 1952 in Europe.

In 1934-35, the Hoover Dam Project, 263 miles from Los Angeles, was developed — utilizing the 287.5-kv transmission level. This voltage remained the highest in the U.S.A. until October 1953, when American Electric Power put into service its first 330-kv (now 345-kv) line.

FOREIGN DEVELOPMENTS. The 287.5-kv level of the Hoover Dam lines remained the highest in the world until 1952, when the first Swedish 400-kv line was energized to transmit power about 600 miles from the generating stations above the Arctic circle to the load centers in the South.



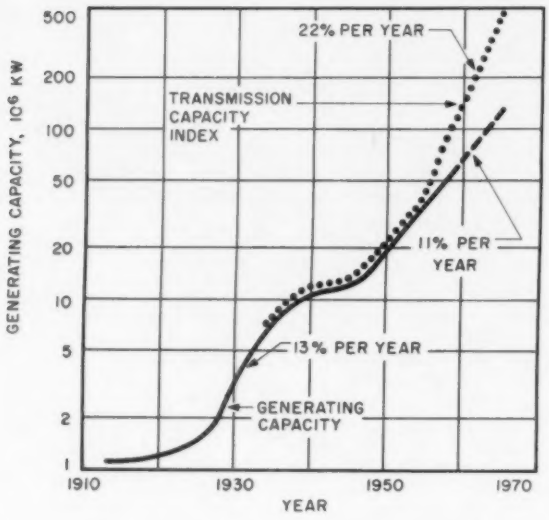


Fig. 4. Generating capacity and the transmission capacity index in the United States versus time

Fig. 5. Generating capacity and the transmission capacity index in the Soviet Union versus time

The Russian, German, French, and Finnish 400-kv systems were energized in subsequent years; and, at present many European countries have, are building, or are planning to build 400-kv lines, which will all fit into the pattern of a planned European *super-grid*, which will eventually interconnect all European nations except the Soviet Union.

In order to make this super-grid practical and economical, all European nations had to agree, very early in their planning stage, to standardize the 380-400-kv (420-kv maximum) voltage level. And of more importance they agreed to stick to this level, despite the urge to raise the voltage of existing or future lines, thereby achieving in their country the highest voltage while reducing the transmission costs. The Soviet Union had originally agreed to the 420-kv maximum level, but soon learned that its extra-high-voltage lines and stations had been designed with overconservatism. Thus, it was possible to raise the operating voltage first to 420 kv (440 kv maximum), and then to 500 kv (525 kv maximum), with no change in the line design, and relatively minor modifications in apparatus.

Thus, on December 27, 1959, *the Soviet Union achieved the highest transmission voltage in the world.* It has been stated that this conversion from 400 to 500 kv will reduce transmission costs in the order of ten per cent. It is not clear, at present, what type of transmission (ac or dc) and what voltage levels will be used for the Soviet Union's future super-grid. Such lines will interconnect all major hydro and thermal stations, from the great rivers in Siberia to European Russia's load centers, and will involve distances up to 1500 miles.

A-c systems up to 700 kv are being investigated, theoretically and experimentally, and a prototype 2 × 400-kv d-c system, from Stalingrad to the Donbass (about 300 miles), is now under construction. The relative economics of a-c systems up to 700 kv, and of d-c systems up to 2 × 700 kv, are being actively discussed in Soviet literature. Probably no definite conclusions will be reached until 1963 or later, when operating experience will be available from the Donbass system.

At present, it appears that the economic break-even point between ac and dc is to be found in the range of 500 to 1000 miles, depending on the power to be transmitted, number of intermediate tap stations, and relative projected costs of the line and apparatus for both systems. For instance, in transmitting 750 Mw per circuit, the break-even point is 620 miles without intermediate stations, and 930 miles with two intermediate stations, according to the latest Russian estimates.

Power transmission at these distances does not appear to have practical applications in the U.S.A. (excluding Alaska) for many years, but may be of interest in Canada and Alaska, where there are still many untapped water resources.

Of greater interest, in relation to future EHV developments in this country, is the Western European development of 400-kv transmission. Three stages may be recognized in this development. At first (1952), 400-kv transmission was introduced in Sweden in order to transmit power from the Northern hydroelectric plants to the Southern load centers, which are about 600 miles apart. This stage corresponds to the classical example of long-distance transportation of energy, with flow of power essentially *in one direction.*

Later (1957), 400-kv transmission lines, about 200 miles long, were built in France and Germany in order to interconnect the Southern section of each country (having predominant hydroelectric generation) with the Northern section (having predominant steam generation). This stage corresponds to system integration, with power flow in *both directions*, according to the seasons.

At present (1961), many countries, including several of relatively small size (such as Switzerland, Italy, and Czechoslovakia), have built, or are building, lines from 20- to 100-miles long, which are super-

imposed over the existing 220-kv system and are also used for international interconnections. Many of these lines are being operated initially at 220 kv and will be transformed later, when economically justified, to 400 kv.

These lines all fit into the planned European super-grid, which is being built, piece by piece, *from the bottom up*, as the need arises, rather than *from the top down* by a supernational power authority, as had been proposed during the power shortages of the postwar reconstruction period. The interesting conclusion is that relatively small countries, corresponding to the size of our Eastern states, are now building 400-kv lines because they are found to be economically justified, and in order to participate in the future benefits of the *super-grid*.

Extra-high-voltage lines are now in operation, or under construction, in many other foreign countries, such as Japan (275 kv), Australia (330 kv), Rhodesia (330 kv), Brazil (345 kv), and Argentina (380 kv).

FUTURE DEVELOPMENTS. After energization, in October 1953, of the first 330-kv (now 345-kv) line by American Electric Power, extra-high-voltage systems have grown very rapidly in the United States and Canada. At present there are 12 utilities which have built EHV lines in these two countries, 10 of them at the 345-kv level. About 10 other utilities are planning to build 345-kv, 460-500-kv lines, or are actively investigating these voltage levels. It is interesting to note that all of these EHV developments (except the first) have taken place since 1953.

In order to predict future developments of EHV power transmission, it is interesting to study the growth of transmission lines in the U.S.A. since 1926, the earliest year for which statistics are available. Figure 2 shows total circuit miles, by voltage ranges, and present growth trends. It is seen that the relative number of lines below 90 kv is gradually decreasing, while the relative number of higher-voltage lines, particularly 132 kv and up, is gradually increasing.

Linear extrapolation, for the next 20 years of the total circuit-miles curve, yields approximately 900,000 miles by 1980, but the sum of the extrapolated values of the individual voltage ranges would be approximately 1,000,000 miles. This discrepancy indicates that there must be a continuing gradual shift towards higher voltages.

Historically, as loads have increased, so have the maximum system voltages (Fig. 1). This has facilitated the interconnection and integration of area- and power-growing utility systems through the superposition of a higher system voltage upon those already present, thereby evolving and building up an ever-stiffening backbone transmission structure. In many systems, the increased step to a new voltage has been of the order of two (or more) times the highest voltage level in operation.

Since the power capability of a transmission line is approximately proportional to the square of the voltage, this means that the ratio of the number of separate lines required between the old and new voltage levels is at least 4 to 1. Therefore, in first approximation, *transmission voltage levels* should increase at *half* the rate of growth in *electric utility generation*, in a manner illustrated in Fig. 1.

Transmission capacity index will be defined as ΣE^2L, where E is the line voltage and L the line length. In the United States this index shows, in Fig. 4, a remarkable correlation with the installed generating capacity. This close parallelism between the two curves indicates that transmission distances have remained constant in the U.S.A., and therefore the need for voltages higher than 220 kv was less urgent than in several European countries, where transmission distances have been increasing gradually.

INCREASING DISTANCES. The vast majority of transmission lines in the U.S.A., from 138 kv and up, are less than 100 miles in length and correspond to the length of transmission lines which were being constructed at lower voltages around 1897 (81 miles at 33 kv). A few lines, however, have line lengths approaching the longest distances of 300 miles, which occur at all voltage levels from 132 kv and up.

The need to transmit larger and larger blocks of power over one right-of-way, rather than the increase of transmission distances, was responsible for the rapid development of 345-kv systems in the U.S.A. and Canada. Since 1953, the average growth in investor-owned 345-kv transmission lines has been at the rate of about 350 circuit-miles per year.

In contrast to present developments in the United States, transmission distances are now rapidly increasing in the Soviet Union. Figure 3 shows the development of transmission lines in the Soviet Union, by voltage class. Figure 5 shows the development of generating capacity, and the transmission capacity index in the USSR. It is seen that these two quantities increased proportionally from 1935 (the earliest year for which complete data are available) to 1955. In 1956, the USSR energized the first section of its 400-kv (now 500-kv) system, which is now growing at the spectacular rate of 22 per cent per year, or *doubling in length every three years*.

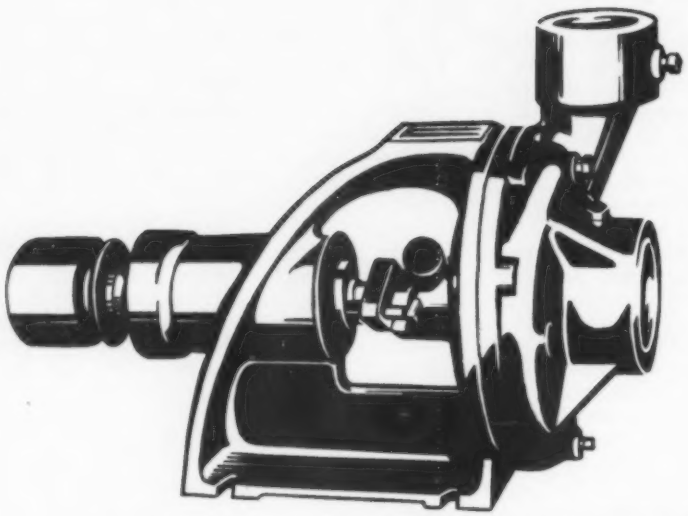
Figure 5 indicates that, according to present Soviet plans, the ratio of the transmission capacity to generating capacity should be four times greater in 1965 than in 1955. Thus the average transmission distance over which electric power flows in the Soviet Union would be four times greater in 1965 than in 1955. It is doubtful whether this ambitious goal can be practically attained in 10 short years; and, in fact, recent official pronouncement in the Soviet Union seems to deemphasize hydro power with respect to thermal power.

Considering the North American continent, an examination of present trends in the construction of transmission lines allows a prediction on how the transmission capacity will be subdivided among the various voltages. It is concluded that, (1) 345-kv systems will continue to expand rapidly in the U.S.A. and Canada; (2) a new voltage level, probably 500 kv, can be expected during the 1960 decade in the U.S.A., and possibly preceded by Canada; and (3) a higher voltage, of the order of 700 kv, may be introduced after 1970, although voltages higher than 500 kv do not appear to be economically justified at the present time.

The table gives the surge impedance loading (SIL) of transmission lines for representative voltage levels. Transmission lines up to 100-miles long can be economically loaded up to twice the surge impedance loading. For distances over 100 miles, this ratio decreases gradually with increasing length and becomes equal to unity for 300 miles. Thus, for distances prevalent in this country, 1000 to 2000 Mw can be handled on a 500-kv single-circuit line with bundle conductors, and 2000 to 4000 Mw on a double-circuit line. Therefore, transmission voltages of this level appear to be adequate for the largest station sizes in the next decade or two.

Editor's note: In succeeding articles, Dr. Abetti will discuss Design Criteria, and will describe the development of "Project EHV."

More on Project EHV in July



DON'T BELITTLE PUMP SELECTION

D. H. Kregg, Burns and Roe project manager, stresses need for care in choosing these items for plant design

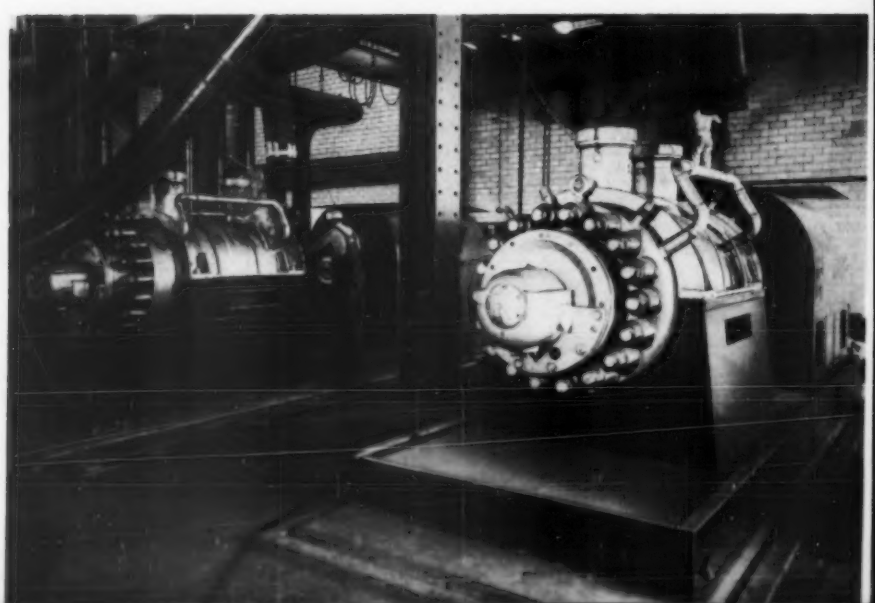
TWO AND EIGHT-TENTHS per cent seems rather small. But when the capital investment is $120 million, as in the case of the Thos. H. Allen Electric Generating Station in Memphis (Tenn.), then this percentage becomes significant. It represents the amount spent on only one type of equipment: pumps, some 104 units ranging in size from 5000-hp motor-drive, 2290 gpm boiler feed to ¼-hp chemical feed delivering less than 2 gph. Obviously, selecting these pumps called for more than casual consideration.

Though perhaps not as glamorous as the station's huge boilers and turbine-generator units, pumps chosen for each application were as carefully picked as the major generating components. It's no secret that auxiliary equipment such as pumps can easily prove to be the weak link in over-all performance of any plant.

Choosing a pump for any application is principally a matter of extensive investigation. First, capability. Can it do the job, particularly during peak load conditions?

Second, reliability. Is the unit available when needed, or is it apt to be out of service because its seals or packing need attention, its bearings have been overheating, it vibrates excessively, and so on?

Third, and equally important, how much will it cost to operate the pump? What is its power input requirement? Because an electric generating station's salable product is power, the more its auxiliary equipment consumes, the less there is for distribution to its customers.



Service	No. of Units	gpm	Differential Head (ft)	Motor HP	RPM	Equipment Included	Contract Cost — $	Pump Manufacturer	Motor Manufacturer
Boiler Feed Water	9	2290	7225	5000	3475	Spare rotating element, Fluid drive, Motor, Recirculation Controls	2,082,432	Pacific Pumps Inc.	Elliott Co.
Condensate Multisection	6			700	1160	Spare Rotating element Motor Recirculating Pump	380,500	Byron Jackson	General Electric
1st Section		2710	200						
2nd Section		2930	75						
3rd Section		3060	125						
4th Section		3210	280						
Condensate Recirculation	3	900	190	50	1760	Motor			
Circulating Water	6	63,500	57	1250	360	Synchronous Motor & Exciter	663,779	Worthington Corp.	Electric Machinery
High Pressure Ash Water	6	1,000	720	250	3550	Motor	157,542	Worthington Corp.	General Electric
Low Pressure Ash Water	4	800	290	100	3500	Motor			
Screen Wash	3	1,650	260	150	1775	Motor			
Bearing Cooling Water	6	1,850	195	125	1750	Motor			
Lube Water	2	100	100	5	3510	Motor			
Slag Monkey	6	40	190	7½	3500	Motor			
Air Heater Water Coils	6	1,350	175	75	1750	Motor			
City Water Booster	2	1,000	140	50	1750	Motor			
Ignition Oil	3	15	300 psig	7½	1750	Motor		DeLaval	Allis-Chalmers
Basement Sump	6	1,200	55	25	1750	Controls	36,200.00	Deming Co.	Westinghouse
Blowdown Sump	6	200	50	5	1750	Pit Covers			
Condensate Pit Sump	6	30	65	2	3500				
Reclaim Hopper Sump	4	30	40	1	1750				
Chemical Feed							32,232.26	Milton Roy Co.	
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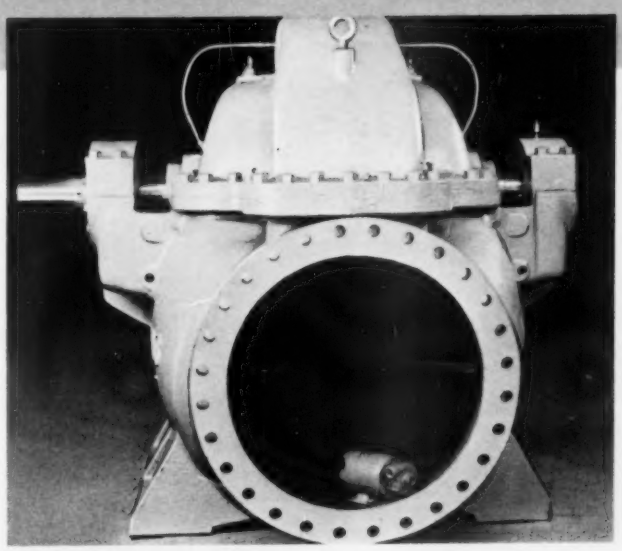
Table gives data on pumps chosen for the Thos. H. Allen Station—largest ever authorized at one time by a municipality



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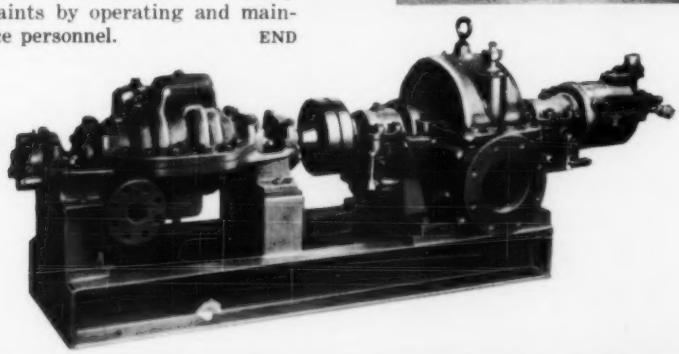

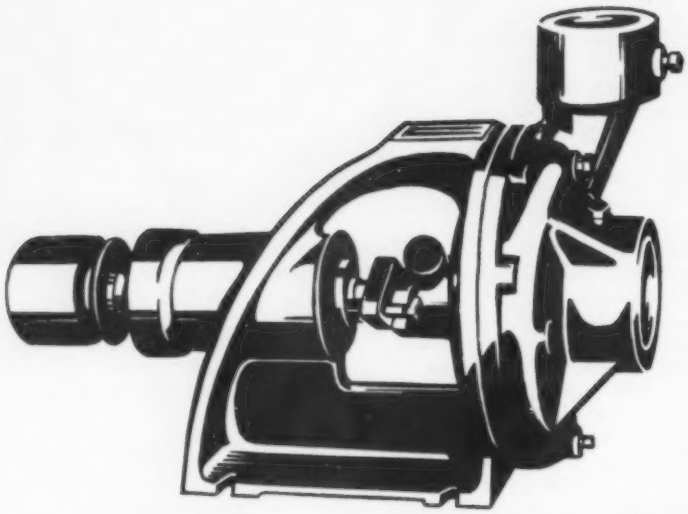

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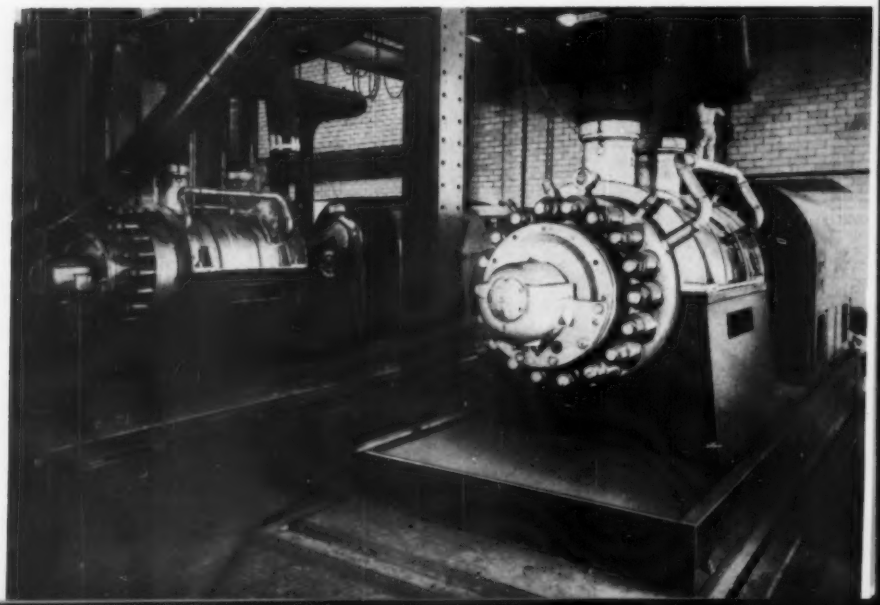

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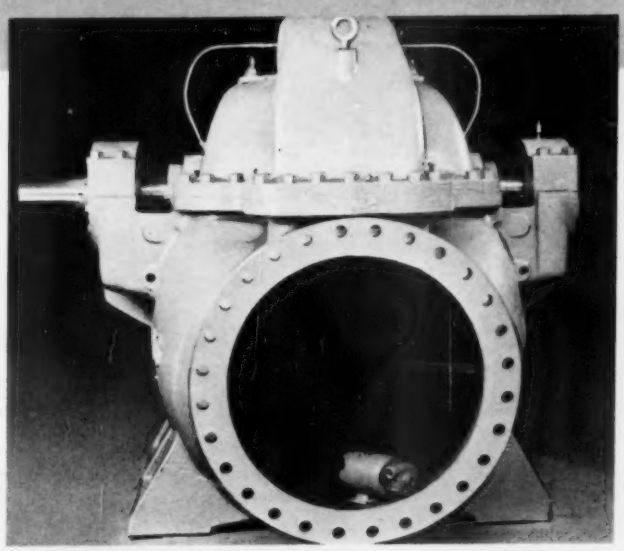

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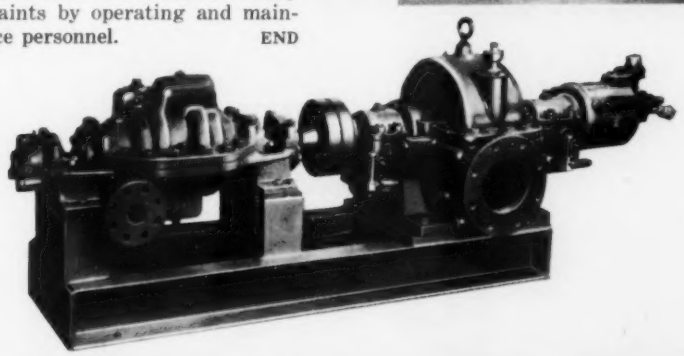
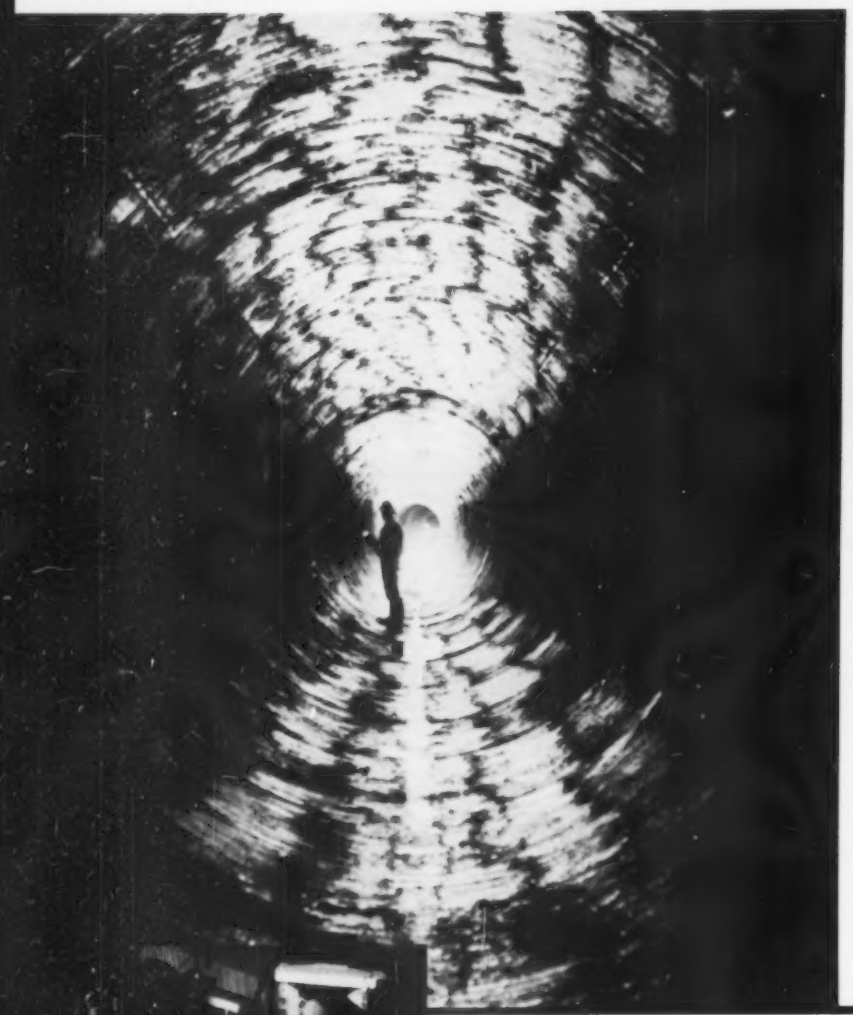
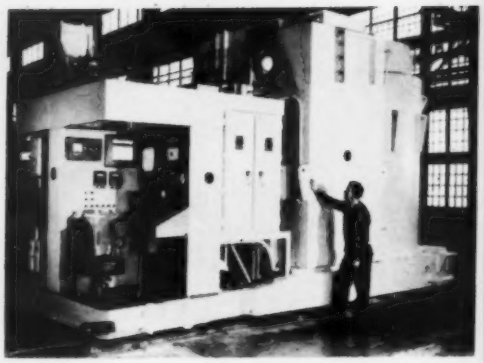




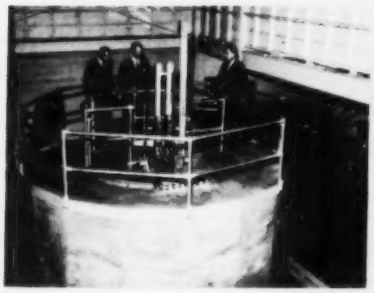


This vehicle is called a transfer cask car. Baldwin-Lima-Hamilton made it for Enrico Fermi atomic power plant. Self-propelled, it removes spent fuel elements, charges fresh elements, transports fuel to storage

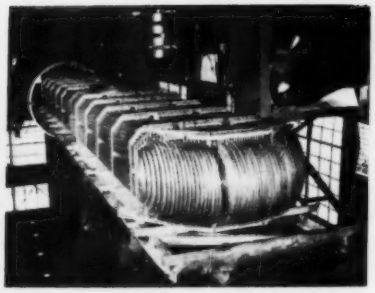
Inside steel penstock at Bersimis River power project in northeastern Quebec, engineer checks coal-tar coating of the steel-plate surface. After 3½ years of service, the enamel was found to be "like new." Inspection of the eight penstocks was done jointly by Hydro-Quebec and the Koppers Company

Power Engineering's

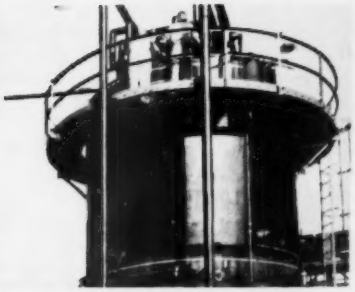
Machining a 17,000-lb pump bowl casting for one of several giant Byron Jackson pumps that will be used in the new production reactor project (NPR) at the Hanford plutonium plant. The Hanford plant is operated in southeastern Washington for AEC by General Electric Co.



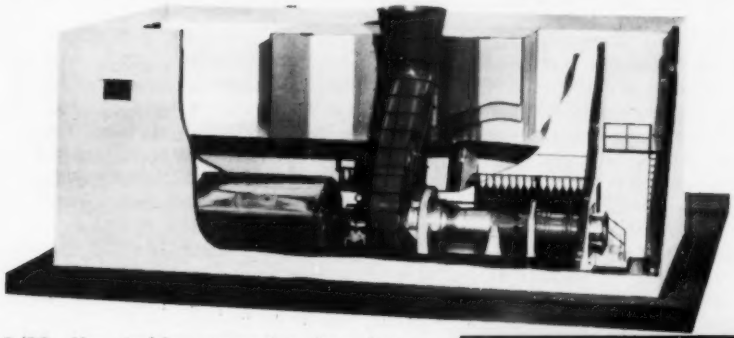
10-kw research reactor dedicated at U of Maryland was made by Allis-Chalmers, financed by AEC



Tube bundles being installed at Combustion Engineering in steam generator for reactor at Hanford

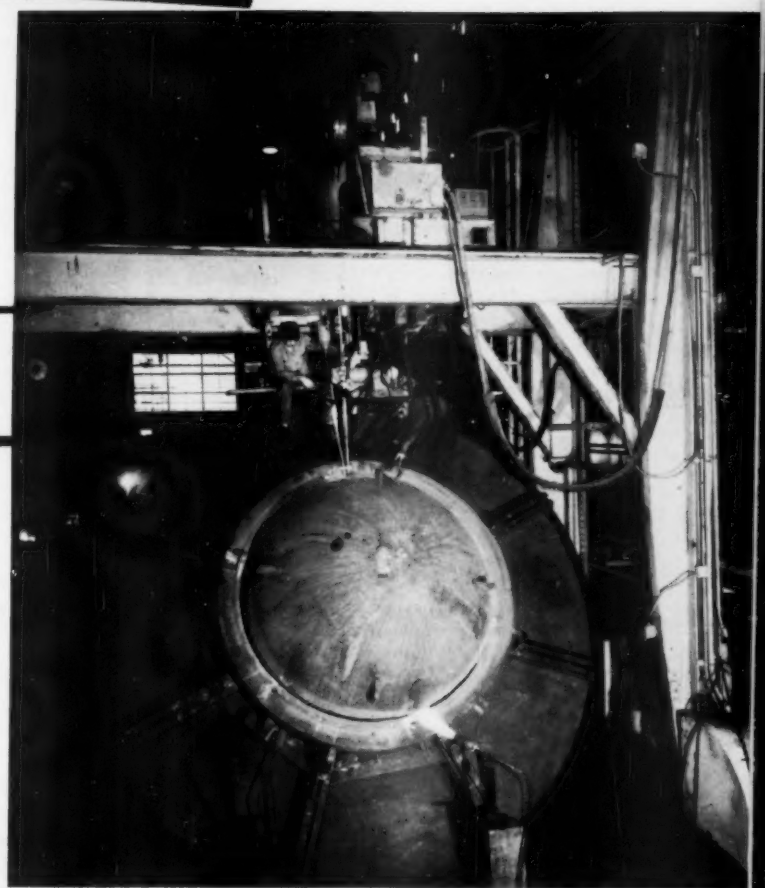


Salt water conversion pilot plant at St. Petersburg, Fla., will use a freezing process, produce 35,000 gpd



15/20 Mw turbine-generator has been ordered from Bristol Siddeley by Britain's Central Electricity Generation Board. Cutaway shows small size of the power unit in relation to power turbine and generator

NEWS REEL



Making head for a nuclear reactor pressure vessel at Allis-Chalmers. The 6-ton flange forging is being submerged-arc welded to the steel reactor head. This pressure vessel is for Northern States Power Co's Pathfinder reactor, first to contain a nuclear superheater integral with the power reactor

WHAT GALVANIC ACTION DOES

Earle M. Sommerfield, of United Engineers and Constructors, here begins a summary of what every power engineer should know about corrosion

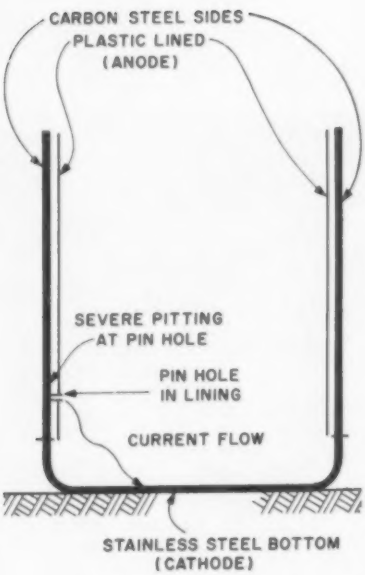


Fig. 1. For economy, sides of tank were of carbon steel; but the lining contained pinholes. This resulted in rapid pitting because of the large ratio of area of the cathode to tiny area of the anode. See Figure 2 for galvanic action analysis

IT IS ESTIMATED that the loss due to corrosion in the United States alone approximates $6 billion per year. In days gone by, when streams and the atmosphere were not as polluted as they are today, when demands of high pressures and temperatures did not exist, and when fuels did not contain excessive sulfur and vanadium, the matter of protection against corrosion was an art and one of comparatively small moment. However, it has now become a science, and one which has many facets, as a few examples will quickly attest.

Take for example the case of a storage tank with a stainless steel bottom[1] to reduce corrosion of the bottom, which rested on the ground. In the interest of economy, the sides of the tank were constructed of carbon steel and lined to prevent corrosion of the carbon steel which would result from the dissimilarity of the metals (see Fig. 1). The point that was overlooked was that the type of lining used contained pinholes, which resulted in rapid and severe pitting of the sides of the tank at these imperfections, because of the large ratio of the area of the cathode (the stainless steel bottom) to the tiny area of the anode (the carbon steel exposed at the pinholes).

Remedy was to line the stainless steel bottom also, which brought the ratio of areas of exposed cathode and anode more closely into balance, thus greatly reducing the intensity of galvanic current flow, with corrosion at the pinholes reduced to the point where the installation was economically satisfactory.

Or take the case of a large seacoast public utility which had 1867 *tons* of condenser tubes in service.[2] At a price of 76 cents per lb, this represented a replacement value of over $3 million. Whether these tubes last one year or 30 to 40 years is certainly of immediate significance economically.

Before World War II, all was serene at this plant, with Admiralty tubes and circulating water velocity through the tubes of 7 fps. But then came the war, with its shifts in population. Greatly increased dumping of industrial wastes and sewage into the sea near this plant, coupled with the lack of adequate cleaning of the condenser tubes because of a shortage of generating capacity, resulted in tube replacement on a large scale. This continued for eight years before the problem was solved.

The cast iron water boxes also suffered from severe graphitization. In the meantime, the original Admiralty tubes had been replaced with aluminum brass which gave satisfactory life. To combat the water box condition, zinc anode plates were installed in the water boxes, but had to be removed because of their adverse effect on the aluminum brass tubes. Subsequently, iron waste plates were installed in the water boxes to provide the necessary iron for formation of a protective iron oxide film on the aluminum brass tubes. The water boxes were finally satisfactorily protected by a lining of 1¼-in. gunite applied over a 2 by 2-in. mesh of No. 14 gage Type-304 stainless steel wire.

GALVANIC ACTION. Since the greatest culprit in the world of corrosion is galvanic action, a short discussion

CORROSION ABC'S FOR POWER ENGINEERS

of this phenomenon is in order. It is not necessary to be aware of all the complications of the electrochemical theory of the galvanic cell. Main fact to remember is that a difference of potential is set up when dissimilar metals are immersed in an electrolyte, and that the current flows from the "anode" to the "cathode" *within* the electrolyte (see Fig. 2).

The metal of the anode combines with the oxygen of the electrolyte and lays down an oxide film on the anode. If a suitable film is deposited on the anode, the film will prevent current flow, and the destructive action ceases. Simultaneously, hydrogen bubbles are formed on the cathode, and if they are formed in sufficient quantity and remain on the cathode, they too would prevent current flow and destructive action.

However, the hydrogen usually combines with the oxygen of the electrolyte to form water, which action *depolarizes* the cathode, thus permitting continuation of the destructive current flow if a suitable film has not been deposited on the anode.

Another important point to keep in mind is the relation of the physical area of the cathode to that of the anode. If the cathode area is large and the anode area small, the corroding action at the anode is far more intense than if these areas are equal, or if the area of the anode is greater than that of the cathode. This was the case of the tank mentioned above.

If the use of dissimilar metals cannot be avoided, it is important to choose metals as close together in the galvanic series as possible and to make the smaller part of the nobler metal.[3] The table shows the galvanic series for metals and alloys in sea water. The top of the series is the anodic end and the less noble and the one which corrodes:

Anodic end, less noble (corrodes)
- Magnesium
- Zinc
- Alclad 3S
- Aluminum 3S
- Aluminum 61S
- Aluminum 63S
- Aluminum 52
- Low steel
- Alloy steel
- Cast iron
- Stainless steels (active)*
  - Type 410
  - Type 430
  - Type 304
  - Type 316
- Ni-resist
- Muntz metal
- Yellow brass
- Admiralty brass
- Aluminum brass
- Red brass
- Copper
- Aluminum bronze
- Composition G bronze
- 90/10 Copper-nickel
- 70 + 30 Copper-nickel-low iron
- 70 + 30 Copper-nickel-high iron
- Nickel
- Iconel
- Silver
- Stainless steels (passive)*
  - Type 410
  - Type 430
  - Type 304
  - Type 316
- Monel
- Hastelloy C.
- Titanium

Cathodic end, more noble.
*refers to condition of surface

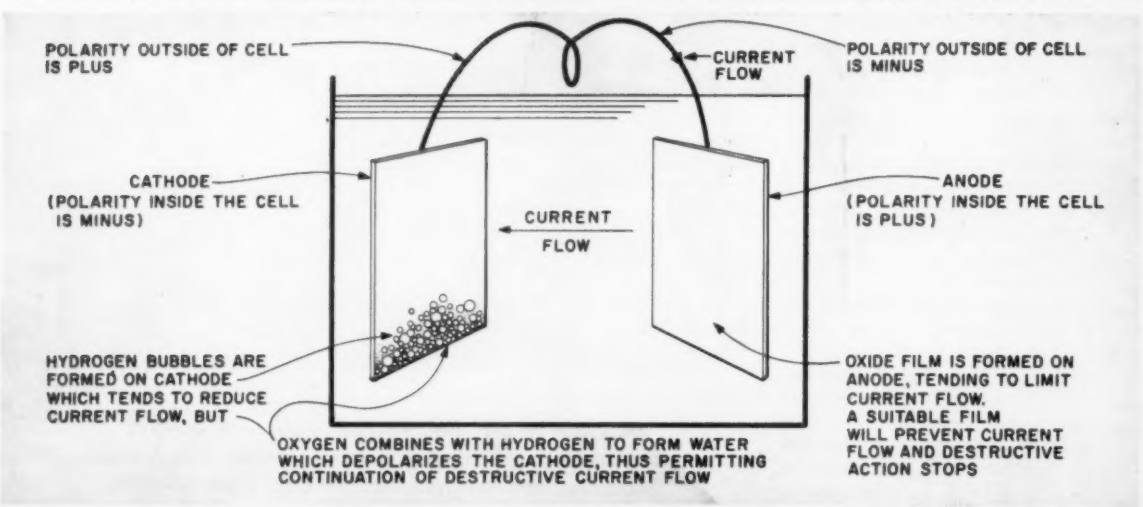
STRAY CURRENTS (ELECTROLYTIC). Galvanic action can also be caused by stray currents, which may be present around a power plant, and especially in areas traversed by electric traction lines. Stray currents play havoc with underground pipe lines and the bottoms of metal tanks. Protection is accomplished by coating the exposed metal with asphaltic or other suitable materials, by cathodic protection, or both. Tankage should also be installed with good underside drainage to prevent the accumulation of water.

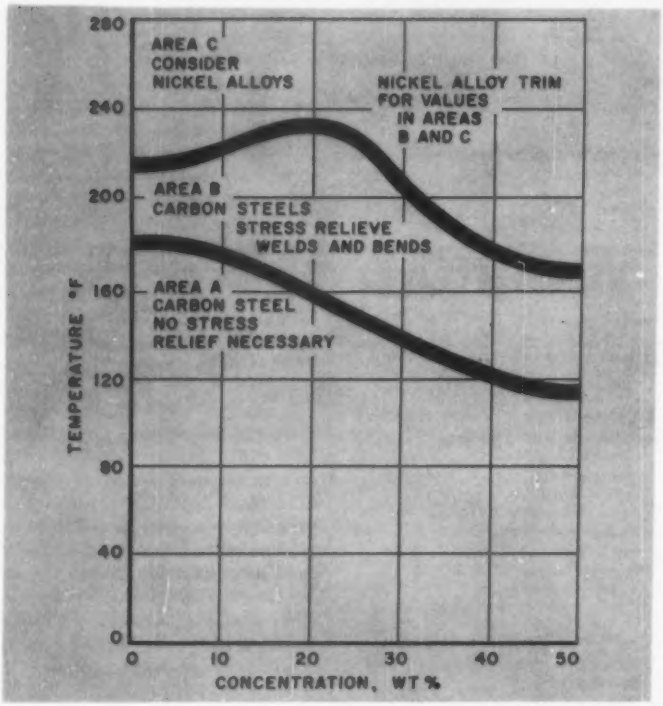
Another important item in this connection is that stray currents can cause serious destruction of reinforced concrete structures, especially when chlorides have been added to the concrete mix to prevent freezing during winter construction.[4]

The chloride additive causes the concrete to become electro-conducting, and the chlorine ions contribute to the destruction of the protective films which are formed on the reinforcing steel under the action of the alkaline concrete. Moreover, the iron chloride which is formed in the corrosion process reacts with the alkaline concrete, forming ferrous hydroxide. Considerable increase in volume results which causes cracking of the concrete, which in turn accelerates the corrosion and the destruction of the entire structure. A number of buildings and bridges in America have disintegrated for this reason. Keep in mind that the use of cathodic protection can also result in the destruction of reinforced concrete.

STRESS CORROSION. Stress corrosion is also a manifestation of galvanic action. Stress corrosion is to be distinguished from stress corrosion cracking, since cracks are not evident in pure stress corrosion. Stress corrosion, as its name implies, results from stress imposed by work-

Fig. 2. How galvanic cell action works. Immersing dissimilar metals in an electrolyte sets up destructive current flow


POLARITY OUTSIDE OF CELL IS PLUS
CURRENT FLOW
POLARITY OUTSIDE OF CELL IS MINUS
CATHODE (POLARITY INSIDE THE CELL IS MINUS)
CURRENT FLOW
ANODE (POLARITY INSIDE THE CELL IS PLUS)
HYDROGEN BUBBLES ARE FORMED ON CATHODE WHICH TENDS TO REDUCE CURRENT FLOW, BUT
OXIDE FILM IS FORMED ON ANODE, TENDING TO LIMIT CURRENT FLOW. A SUITABLE FILM WILL PREVENT CURRENT FLOW AND DESTRUCTIVE ACTION STOPS
OXYGEN COMBINES WITH HYDROGEN TO FORM WATER WHICH DEPOLARIZES THE CATHODE, THUS PERMITTING CONTINUATION OF DESTRUCTIVE CURRENT FLOW



From Chemical Engineering

Fig. 3. Chart of caustic soda temperature ranges for pipe and valves

ing the metal, such as punching or drilling. The area just adjacent to the working is made anodic due to the stress[1], while the unworked area remains cathodic. If the environment is an electrolyte, a galvanic cell is set up, usually with a small anodic to cathodic ratio, resulting in corrosion at the anodic area. Annealing of the deformed metal to restore it to its original state may assist in reducing the corrosion rate.

When under the combined influence of sufficient *residual* tensile[5] stress and exposure to a critical corrosive environment, almost any metal can be made to fail by stress corrosion cracking. Corrosion as measured by loss of metal is usually negligible. Chloride solutions are the worst offenders in promoting stress corrosion cracking of *stainless steels*.

Caustic solutions and nitrates will crack steel if concentrations and temperatures are critical. Mercury and ammonia will readily crack strained brass. (This is the reason for the mercurous nitrate test of condenser tubes—to determine if internal stresses are present.)

The mechanism of stress corrosion cracking involves a complicated sequence of corrosion and fracture. It has been shown that fine pitting is needed to start the activity. The pit initiates a mechanical crack at a right angle to the maximum strain. Further progress is then a process alternating between corrosion and mechanical cracking until the material fails completely. A form of this type of corrosion which is familiar to at least the older power engineers is the caustic embrittlement of boiler drum plate.

This takes place under the action of alkalies at elevated temperatures[4] and results in a large reduction of the ductility of the metal due to destruction of the grain boundaries. The mechanism consists of sodium bicarbonate in the feedwater being decomposed to form the caustic, sodium hydroxide. Prevention consists of adding sodium sulphate to the boiler water. The sulphate precipitates, which protects the metal from the alkaline attack. The substitution of sodium phosphate for sodium carbonate in the treatment of the feedwater can also bring helpful results. Caustic embrittlement occurs particularly easily in steels with a high nitrogen content, whereas steels containing nickel are resistant.

To avoid stress-corrosion cracking, present practices are to stress relieve the equipment by thermal treatment or to use a material which is not subject to cracking in the particular environment. Steels containing 3 to 5 per cent nickel have found practical application.

Since caustic is widely used in the chemical industry[5], the chemical engineers have developed a chart to show the areas involved for pipe and valve specification (see Fig. 3).

Stress corrosion cracking of brass condenser tubes is sometimes referred to as "season cracking."[6] Cracking of this type is usually confined to alloys of copper and zinc containing less than 85 per cent copper. The cracks are longitudinal. Unless otherwise specified, condenser tubes are finish annealed and are not in a condition to season crack during storage or service.

It is important to distinguish between stress corrosion and corrosion fatigue. Stress corrosion is the result of *residual* stresses, set up by forming or working the metal, whereas corrosion fatigue is the result of alternating stresses imposed in operation of the part when exposed to a corrosive environment.

The power engineer is concerned with corrosion fatigue in the operation of pump rods, discs and vanes of turbines, and the superheaters of steam boilers.

Such fatigue results from vibration of the equipment[4,5]. A crack starts at the base of a small pit (the pit caused by corrosive action) and proceeds in a straight path (trans-crystalline), similar to ordinary fatigue. In tubes, the cracks are circumferential. Elimination of vibration or the use of a more resistant metal are the most usual cures. However, factors which reduce corrosion in general also reduce the effect of corrosion fatigue. If oxygen is removed from the system or if a sufficient quantity of chromates is added, the limit for corrosion fatigue is raised. The fatigue limit will also be raised by the use of stainless steel, nitriding, and finer finish of exposed surfaces. END

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2. Solving Corrosion Problems of Electrical Generating Plants, L. Baskette, *Corrosion*, vol. 15.
3. How Oxidative Corrosion Occurs, R. V. Jelinek, *Chemical Engineering*, Aug 25, 1958.
4. Factors Influencing Corrosion, G. V. Akimov, *Corrosion*, Sept, 1959.
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6. Heat Exchanger Tube Manual, 2nd edition, Scovill Mfg. Co.

In later issues, Mr. Sommerfield will describe various kinds of corrosion and explain those major factors that interact in the corrosion process

BIG WATER AND POWER PROJECT GOES FORWARD ON FORMOSA

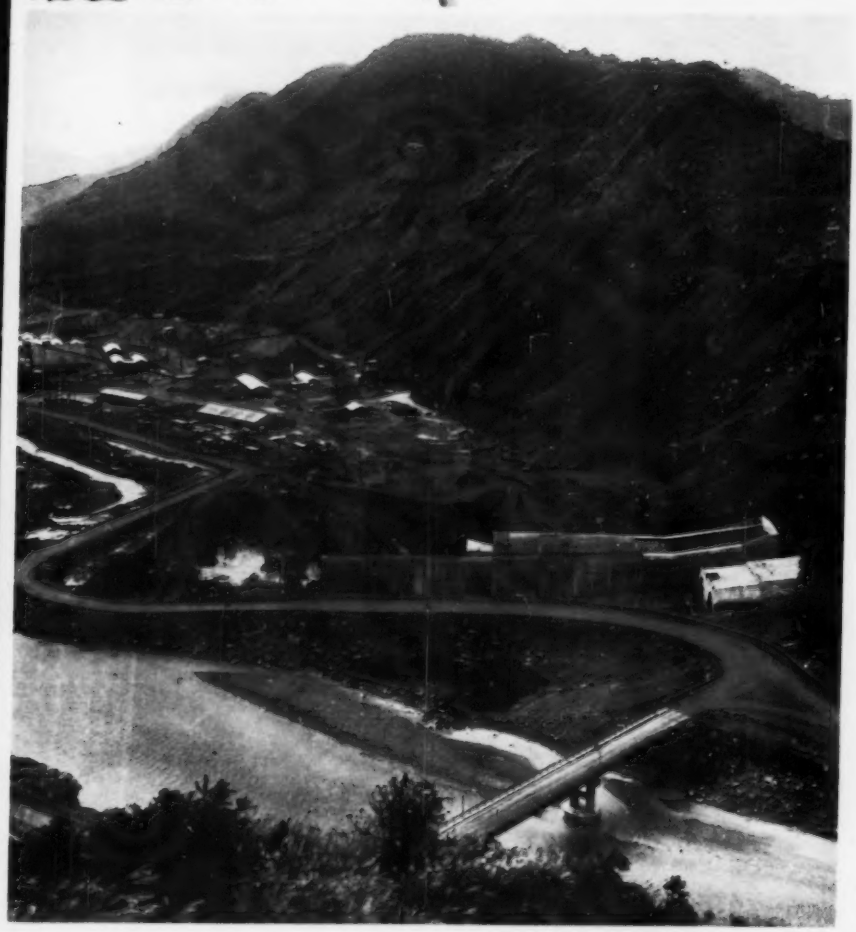
Shihmen development is supported by U.S. funds and engineering

FIRST LARGE-SCALE water resources development undertaken by the Republic of China is beginning to take form in the area southwest of Taipei, Formosa. The Shihmen Development project involves building of a reservoir three miles wide and ten miles long, and will include a 436-ft-high rock-filled dam. The project will provide irrigation services that will develop more than 100,000 acres of land in northern Taiwan, helping to increase rice production by 74,000 tons each year.

Although it has been designed primarily as an irrigation project, vital to the expansion of food production, the undertaking includes a powerhouse, two 45,000-kw generating units, a chute spillway and a 17-mile-long canal system that insures ample water supply for a huge surrounding area. Power installations are expected to be completed by 1963, and will supply industrial and residential electrical needs.

Total construction estimates are budgeted at some $65 million, with the United States expected to provide almost half the total. The Development Loan Fund is to make available at least $21,500,000 of the needed funds while another $8,500,000 is to come through U.S. aid repayable with interest on long-term credits.

There are now 3000 Chinese technicians and engineers reported to be working on the development, assisted by some 50 American engineers and specialists. Tippetts-Abbett-McCarthy-Stratton, consulting engineers of New York, have been engaged by the Shihmen Development Commission to advise on the project while the Morrison-Knudsen-International Construction Co. is directing construction. END



Diversion tunnel and two penstock tunnels take shape. Power installations will add 90,000 kw to Taiwan's electric supply for all uses

HELICOPTER FLIES CONCRETE TO TOWER SITES IN MOUNTAINS

Southern California Edison construction crews use chopper to eliminate need for access road

AMONG THE NOVEL USES to which Southern California Edison Co. has put the versatile helicopter is as an airborne *cement truck*. On two recent heavy construction jobs in rough terrain, Edison used a huge Sikorsky S-58 to airlift tons of concrete to remote areas for placement as footings for steel transmission power line towers. On one of the projects, in the Soledad Canyon area north of Los Angeles, the hard-working 'copter hit a rate of carrying 10 tons of concrete per hour, although the accessory equipment it was using had not been intended originally for aerial use.

Since Edison was pioneering, and the use of a high-level concrete carrier was strictly experimental, heavier-than-necessary steel buckets were used to haul the concrete. They had a capacity of one-half cubic yard and were equipped with rubberized sleeves—to funnel the concrete into hoppers at the tower sites.

Two buckets were used in the operation. One was filled from the commercial premix truck at the staging area, while the other—attached to a hook dangling beneath the 'copter—was being flown to the tower site. A special release cable made it possible to pour the load when it was precisely over the forms. The Soledad Canyon job took place in a five-mile section of the 69-mile-long second Saugus-Mesa 220-kv transmission line, constructed by Edison.

ANOTHER EDISON PROJECT involving air-delivered concrete was the construction of a 66-kv transmission line linking the company's Saugus and Chatsworth substations. A portion of the line passing through the Santa Susana mountains was built *entirely without the use of access roads*. Men and equipment were first flown in to clear each tower site and to dig foundation holes. Cement-hoppers were then airlifted to the sites for receiving the concrete loads, and next came the deliveries.

Enough concrete for the four tower footings was poured in about 20 minutes, a job normally requiring an entire day using ground forces alone. In this operation, as an experiment, the helicopter even picked up one small, complete tower, carried it over ridges and gorges, and placed it gently on its footings.

In addition to these two projects utilizing a large helicopter, Edison also recently put its own, newly-acquired Hiller 12 E to work hauling concrete. A total of 18½ cubic yards of concrete was poured by the Hiller (for three small towers), located only half a mile away from a field that was suitable for landing, but in such rough terrain that the only alternative would have been laboriously carrying in the rock, sand, and cement by foot. A special bucket of canvas was designed for the job by engineers from Edison and the Owl Construction Company. It could handle about 5 cubic feet of concrete per load.

EDISON ALSO HAS USED helicopters to set wood distribution poles, and regularly puts them to work patrolling transmission lines; they are used for carrying hydrographers to the back country of the High Sierra mountains, where snow surveys are made in connection with the company's Big Creek-San Joaquin River hydroelectric development northeast of Fresno, California. END

UNITED NATIONS PLANS INTERNATIONAL POWER CONFERENCE

U.N.'s Economic Commission for Latin America organizes a comprehensive power conference to be held in Mexico City, July 31 to August 12

ELECTRIC POWER is a key factor in the industrial growth and economic development of a country. This was recognized early by the United Nations, which started, in 1955, to plan a Latin-American Power Seminar.

The Conference will be held in Mexico City, July 31 to August 12, 1961, at the headquarters building of the Comision Federal de Electricidad, Calle de Rodano 14, Mexico City. The program chairman, Adolfo Dorfman, of Santiago, Chile, expects over 200 active participants.

At Bogota, Colombia, in 1955 the U.N. Economic Commission for Latin America recommended this Electric Power Seminar. It was developed under the auspices of the Economic Commission, the Bureau of Technical Assistance Operations, and the Resources and Transport Economics Branch of the United Nations, with the active participation of the Government of Mexico.

Since this Seminar was the first of its kind to be held in Latin America, a great deal of planning was involved. A preparatory meeting held in New York in September 1959 approved the proposals of ECLA. These included a program and a tentative agenda of prospective reports to serve as a basis of discussion. A questionnaire was distributed to all Latin-American countries in order to provide basic data needed for some of the Secretariat papers. Adolfo Dorfman, Director of the Energy and Water Resources Program, has been handling the arrangements from his office with the United Nations Economic Commission for Latin America, Casilla 179 D, Santiago, Chile.

As shown by the Conference outline in the listing, the Seminar has been limited in scope to specific topics so that a homogeneous group with common interests could be assembled. Essentially, the Seminar will be an analysis of the main economic, financial, technical, and organizational problems that affect the development of electric power and electric power systems in Latin America. Basic papers have been prepared by the ECLA Secretariat by selected Latin-American technicians. The Seminar will be organized with plenary meetings and working committees, the latter with morning and afternoon meetings.

While this is being held under the auspices of the United Nations, all participants will attend in a personal capacity and not as representatives of their governments. It is not intended that the Seminar should make decisions or recommendations of an official nature, but that the final report will consist mainly of an analysis of the special electric power problems encountered by specific Latin-American countries, and that the Seminar groups will make suggestions for the solutions of these problems. END

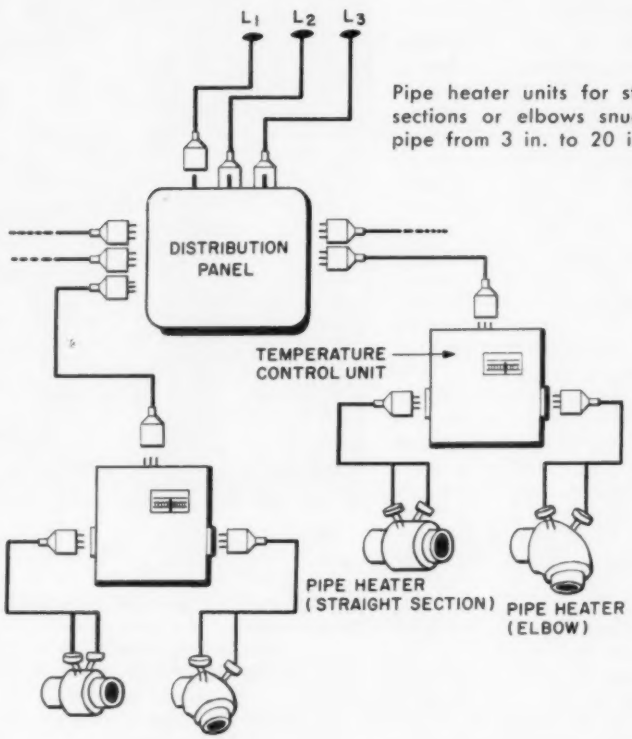
General outline of the conference which covers economics, financial, and technical phases of electric power development in Latin-American nations

1. Economic and Financial Problems and Trends of Electric Power Development in Latin America. Nine papers from South and Central America, the Caribbean, Asia, and the Far East.
2. Evaluation and Projection of the Demand for Electric Power, Evaluation of Future Requirements, Forecasting and Correlation With Other Indices. Seven papers from the U.S. and Europe.
3. Financing, Rate Structures, and Economic Criteria for Power System Development. Eighteen papers from South and Central America, the U.S., and the United Kingdom.
4. Development of Electric Systems, Combined Thermal and Hydro Operation, from Chile, Canada, Brazil, Mexico, El Salvador, Trinidad, West Germany, France, U.S., United Kingdom.
5. The Measurement and Utilization of Hydroelectric Resources. Nine papers from Portugal, U.S., Chile, and Mexico.
6. Nuclear Power Cost Trends, International Activity and Application to Existing Systems. Three papers from Austria and Mexico.
7. Fuel Yields, Economic Fuel Utilization, and Equipment Adaption to Latin-American Conditions. Three papers from the U.S. and the United Kingdom.
8. Development of the Electrical Equipment Industry in Latin America. Two papers from Chile and Brazil.
9. Legal, Institutional, and Tariff Policies and Their Impact on Electric Power Developments. One paper from Mexico prepared as a special ECLA report.

NOTE: Informational papers have also been prepared on various topics of the agenda by the Canadian, Spanish and Yugoslav National Committees of the World Power Conference, and by several U.S. agencies including the Bonneville Power Administration, Bureau of Reclamation and the Rural Electrification Administration.

ELECTRIC-RESISTANCE PREHEAT FACILITATES WELDING PLANT PIPING

Modular strip-heater elements save time on big piping jobs



Pipe heater units for straight sections or elbows snugly fit pipe from 3 in. to 20 in. OD

HIGHER STEAM PRESSURES and temperatures have increased the use of stainless and other high-performance steels in steam generator piping, usually requiring preheat for best results in welding. For accurate, automatic control of metal temperatures before and during pipe welding, a "building block" electrical-resistance strip-heater system has been developed by an eastern manufacturer.

The system comprises standard plug-in units that can be used on job after job. Even unskilled help can quickly install or remove equipment to preheat a pipe welding project of any extent, and add or shift units as the job progresses. The system is safety-engineered throughout to protect people and equipment from electrical and physical hazards.

Plug-in distribution panels, control cabinets, and pipe heater units, with polarized contacts to prevent wrong connections, make it easy to assemble a distribution system for each welding job. The distribution panel, rated 90 kva, takes power from a 220- or 440-volt three-phase line and distributes it to six outlets. A fused plug at the end of a cable to a control cabinet mates with each outlet in the distribution panel.

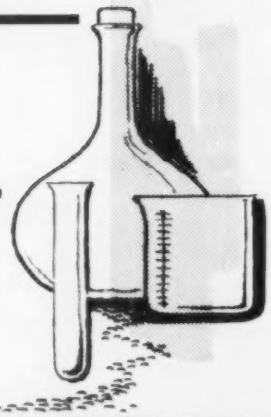
Each control cabinet regulates the current to a pair of heater units, straight section or elbow, on either side of the joint to be welded. A thermocouple on the pipe is connected to the electronic sensing device in the cabinet so that metal temperature is accurately held at the desired preset level. Mating with each of the cabinet's two outlets is a fused plug at the end of a cord to a heater unit.

Plugs engage with their mating receptacles in the distribution panel or control cabinet to make watertight connections. For safety, fused plugs are made so that they must be disengaged before their fuses can be replaced. Added protection against shock and other hazards is provided by neoprene molded construction of panels and plugs, neoprene insulated flexible cables and cords, and equipment-grounded circuits throughout the system.

For more information about this system, please write the Editor of POWER ENGINEERING, 308 E. James St., Barrington, Ill. END

Strip-heater preheat system takes power from 220- or 440-volt, 3-phase 60-cycle source

SOMETHING NEW IN CHEMICAL CLEANING



Dr. Charles M. Loucks describes use of non-condensed phase for cleaning hard-to-get-at surfaces

Fig. 1. This is the pilot plant set-up used for vapor-phase cleaning

USE OF VAPOR-PHASE techniques has received much favorable attention. There has been interest by engineering and production departments and government facilities. Three general areas offer potential application: regular maintenance, preparation of new plant facilities for use, and production-line cleaning where size and shape of parts being fabricated make regular pickling or cleaning facilities awkward to use.

A non-condensed phase is one which tends to occupy entirely the vessel which confines it. Call it a gas or vapor, if you wish, as distinct from the condensed phases, liquids and solids.

Vapor degreasing and steam cleaning are two well-known techniques which border on the use of non-condensed phases. In a process plant when lines, heat exchangers, or vessels become fouled, one of the easiest things to try is to "steam it out." Sometimes this helps, and, if it does, the effect would probably be described as physical rather than chemical. Physical force may also be applied by means of compressed air or any compressed gas for "blowing" to remove objects or dislodge obstructions.

So the use of non-condensed phases for maintenance "cleaning" is not new. But can non-condensed phases be employed for "chemical cleaning," cleaning which involves a chemical reaction between the soil to be removed and reactants brought to the scene by the cleaning fluid?

THE ANSWER. Yes, much chemical cleaning can be done by means of non-condensed phases and, in many cases, with some rather important advantages. Consider the advantages in cleaning large-diameter vessels, intricate piping systems and equipment, such as superheaters, which are designed to carry non-condensed phases only.

Large-diameter vessels can be cleaned without filling them with thousands of gallons of solvent.[1]

If suitable flow conditions can be maintained in pipelines, there is no need for vents and drains, and no jungle of hoses connecting back to the circulating truck. Steam provides its own motive power, so no large pumps are required.

Pendant superheaters should be chemically cleaned by taking advantage of the obvious design features. It hasn't been done so far as I know, but it will be!

Experience has shown that cleaning is (a) amazingly fast and effective, and (b) requires surprisingly small amounts of reactants. (c) In many cases the "fluid" is merely discharged to waste. (d) The process may be stopped and started at will and the change from one reactant to another effected with no loss of time and motion. (e) Loose debris is blown out. (f) Drying of the system is simple, quick and complete. (g) Passivation may involve use of alkali before drying the system. But conversion or film-forming coatings can be applied by similar technique.

PREPARATIONS for such an operation are simple and easily done by plant personnel. The operation itself is self evident. The results usually astonish those who witness them for the first time.

Why has the idea received so little attention? Because corrosion characteristics of the mineral acids commonly used made everyone very conscious of upper temperature limits. Steam temperatures were way off limits.

But one day it was forbidden to use hydrochloric acid for cleaning

a supercritical-pressure steam generator.[2] The use of inhibited organic acids was investigated and at temperatures up to 300 F or more. Since then, citric and formic acid have both been used at temperatures up in the saturated steam range.

It was only necessary to put together the two ideas: the advantages of steam as a non-condensed fluid carrier and the knowledge of inhibited acids that could be used at low-pressure saturated steam conditions. The first "pilot plant" observations were made with formic acid, a volatile acid, and citric acid, a non-volatile acid. The results were interesting and little short of amazing. (See Figures 1, 2, 3.)

AN ASPIRATOR was used to introduce the solvents so no pumps or mechanical equipment of any kind was required. The specimens were 2-inch-diam new iron pipe, in sections about 5 ft long. The reaction time was a matter of minutes, the amounts of material used were small, and the "rinsing," passivating and drying were done in less time than it takes to describe the operation. The illustrations show the results with citric, formic and hydrochloric acid. At the time, hydrochloric acid was used for comparison, without the intention of proposing that it had practical applications. Since that time, it has been found that, in certain instances, hydrochloric acid cleans with such amazing rapidity at steam temperatures that it may have some interesting applications, also.

The first chemical service cleaning job using steam, so far as I am aware, involved 2-inch to 4-inch-diam pipe, new and reused, in place in a refinery. The longest run was 1800 ft of 2 in. swaged up to 4 in. about midway. There was also a double pipe heat exchanger of which the annular space was required to be cleaned. The reagents used, each separately, were formic acid, citric acid, and a chelating agent. Detergents were used for removing oil, grease and loose soil, and soda ash for neutralizing and "passivating."

Same advantages were observed here as in the pilot plant trials: ease, minimum investment in equipment, short reaction time, small amounts of reactants, removal of loose debris, quick effective rinsing and neutralizing; most significant, the ease and speed with which even the 1800-ft section was dried.

Other service jobs on relatively small diameter piping have been done, mostly on new pipe systems for removal of rust and mill scale. However, carbonate deposits have been removed from fly ash lines up to 6 in. diam with steam and HCl.

In any pipe line on which sufficient flow can be maintained to cause condensed phases to flow along the pipe walls, volatile solvents are not necessary. But there is another application where volatility is important.

Engineering aspects of cleaning large-diameter vessels are entirely different from problems of turbulent flow through a pipe. Possible applications have been almost entirely unexplored. But there was one significant application: How to apply nitric acid to the stainless steel interior cladding of vessels approximately 10 ft diam by 30 ft long, such as a nuclear furnace. Nitric acid was introduced with steam and allowed to condense on all internal surfaces. Examination of the surfaces by the copper sulfate test before and after cleaning showed success in removing iron contamination from the stainless steel surfaces.

Any non-condensed phase is a potential medium for chemical cleaning. For cleaning a compressed air system, for example, is there any easier and cheaper way than to use the compressed air as the non-condensed phase for carrying chemical cleaning agents?

FUTURE USE. One reason that the method is not more extensively employed is the newness of the concept. A patent application is now on file in favor of Dow Chemical Co.

There are two very real reasons for the lag[3,4]: first, the investments of chemical service companies in equipment which must be kept busy to provide a return on investment; and second, the understandable reluctance of maintenance departments to act as "guinea pigs" for a method that lacks a record of successful performance for the particular application.

In the cleaning of lines and vessels there are many interesting chemical and engineering problems involving fluid flow, reaction rates, velocities required to remove loose particles. And because material requirements may be substantially less than by conventional methods, and equipment costs may be reduced to a low value, the economic door is open to the use of dozens of materials which have hitherto been considered too costly. Just let your imagination wander a little bit to some of the things that might be done.

END

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1. C. M. Loucks, W. B. Brown. "Atomic Reactor Vessels Cleaned with Nitric Acid Vapor", Feb 20, 1961, issue of *Chem Engrg.*
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3. C. M. Loucks, "Controlling Corrosion During Chemical Cleaning," presented at March 1960 National Conference, NACE, Dallas.
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Fig. 2. Pipe at left was cleaned with inhibited HCl. Center pipes were cleaned with inhibited citric acid; 2-inch pipe at right was not cleaned

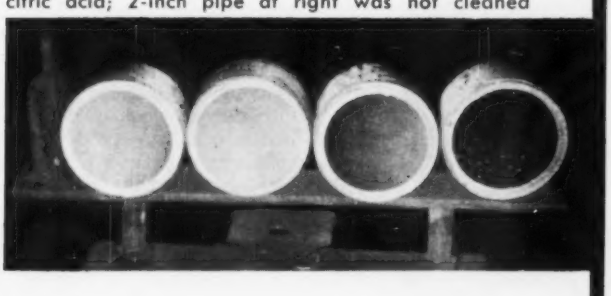
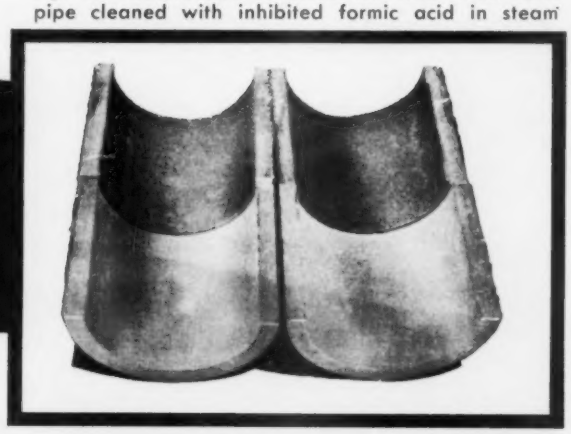


Fig. 3. Before-after sections cut from 2-in. new pipe cleaned with inhibited formic acid in steam



TURBINE FOUNDATION REMOVAL— THE FAST AND SAFE WAY

William C. Conway, of Michigan Blasting Co., describes precision use of explosives

COMPLETE DEMOLITION of an old turbine-generator foundation was accomplished within two weeks at a cost one-third less than that of any other method. This was the more remarkable because the foundation of an operating generator was only 30 feet away. Vibration on the shaft of this generator could not exceed 75/10,000 of an inch, dust had to be held to the minimum, and to throw any chunks of concrete was absolutely forbidden.

Foundation removed extended below the ground floor approximately 10 feet and rested on several large caissons which extended down to bedrock, 20 feet below grade. It consisted of about 350 cubic yards of heavily reinforced concrete above grade, and about 250 cubic yards below grade. A concrete flume just under the floor ran parallel to one side of the foundation. This was cause for considerable concern, since it was in poor condition but had to remain in operation.

A rocklath partition was erected on two open sides for dust protection, as shown at the top, left, of page 60. The holes showing are indicative of the minimum damage incurred. They were caused by a few pieces of concrete which rolled from the top, not by anything thrown by explosive.

Water heads on the drills held dust to a minimum. Vibration was carefully watched by vibrometer instruments on the adjacent generators, and never approached the limiting values.

Three stages above grade floor and one stage below grade blasted the foundation in approximately 10-ft sections. A series of holes was drilled, three or four at a time, and each hole was loaded with about 1½ pounds of dynamite. The charges were set off with delay blasting caps, expending about 5½ million foot-pounds of energy in one charge. This sounds fantastic, but with proper know-how this energy is controlled to do its work with no damage or appreciable vibration. Rope mats were used at all times to protect the charges.

Mr. Edward Wilzer was construction engineer in charge of this Moores Park Power Plant job for the City of Lansing. The photographs show progress on the job.

BLASTING BEDROCK. Another interesting job was the blasting of bedrock for the reactor foundation at the Fermi Atomic Plant, Monroe, Michigan, during the fall of 1956.

About 6500 cubic yards had to be removed by blasting a hole 95 feet in diameter and about 35 feet into bedrock which was about 15 feet below ground elevation. Tolerance on sides and bottom was limited to 3 inches, and the sides had to be sloped 6 inches. This meant that the entire perimeter had to be line-drilled every 6 inches on center, each hole 35 ft deep on a six inch slope.

Purpose of the slope was to wedge the reactor concrete foundation into the bedrock to eliminate floating action.

Precision-controlled blasting is being considered feasible more and more each year in industrial, commercial and residential areas where it was previously thought to be too dangerous. END

EXPERT TEAM WILL DEMONSTRATE BARE-HAND HOT-LINE WORK

Power experts will train utility crews in new method

IN NOVEMBER 1960, the American Electric Power System announced the radically different technique of working hot transmission lines bare-handed. This procedure has revolutionized line maintenance work, and will undoubtedly be the accepted standard in the future.

American Electric Power and Ohio Brass Co. jointly tested the new concept; it was developed by H. L. Rorden, of AEP, and tested under the direction of Dr. Charles J. Miller, of Ohio Brass Co. This new technique is a simple one. It is the reverse of conventional practice and utilizes the principle that current does not flow when there is no difference in voltage between two

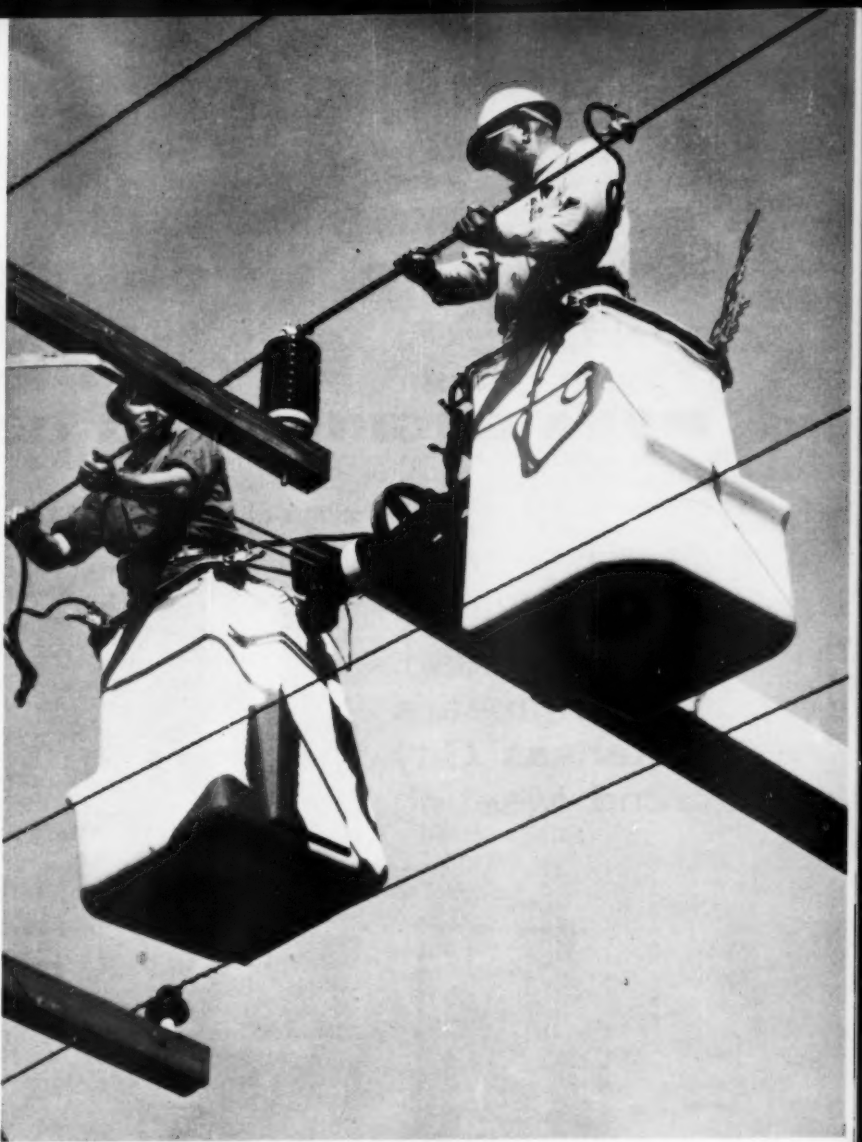
Holan Corporation's Live Line Bare-Hand Team (Daryl E. Gaiennie, left, and Thomas L. Sullivan) is shown with specially equipped HV-50 Elbow. The team is making a coast-to-coast tour of electric utility companies to demonstrate and train crews in a new technique that will enable them to work bare-handed on energized high-voltage lines

points. Heretofore, a lineman has performed his work while grounded and insulated from the live conductor by protective devices, such as rubber goods and insulated hotsticks. With the new method, the lineman is charged at the same voltage as the line on which he is working—a phenomenon of which he is not even physically aware—and protected from ground by effective insulation.

Linemen work while standing in a fiberglass bucket, hoisted to overhead wires by a truck-mounted insulated aerial boom. The bucket is lined with a metal mesh that is connected by clamps to the conductor on which the men are working, thus energizing the screen and the occupants at the same voltage as the line. Their safety is provided by the insulated boom, which protects them from the difference in voltage between the ground and the live conductor.

The bare-hand method, which has been heralded as one of the most outstanding developments in maintenance in the history of the electric power industry, requires proper training and special equipment. The Holan team will teach safe practices to utility personnel, explain the equipment, and demonstrate (through certain job applications) the basic concept of the new method. The new system permits line repairs without interruption of service, eliminates cumbersome tools and equipment, and offers greater safety in many cases than present practices.

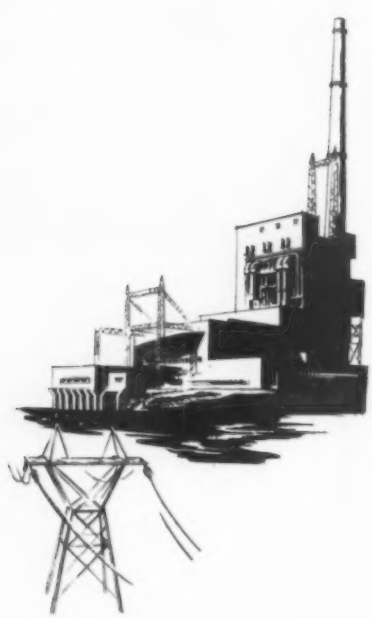
The team is led by Daryl E. Gaiennie, a veteran of more than 20 years as a transmission and distribution specialist and now an executive of Holan Corporation. He has been a lineman, line foreman, and an executive with leading electric utilities. Second member of the team is Thomas L. Sullivan, with 15 years as a lineman, troubleman, line foreman and training instructor in hot-line tools. For more information about this demonstration tour, write the Editor of POWER ENGINEERING.



Linemen stand in non-conducting fiberglass buckets supported by insulated boom. Clamps connect buckets to wire

REPORT ON MVEA ENGINEERING CONFERENCE

Missouri Valley Electric Assn. power engineers in Kansas City at 32nd Meeting



UTILITIES ENGINEERS in the Missouri River Valley Electric Association held their Annual Engineering Conference in Kansas City recently. This was their 32nd meeting, and it proved to be wholly top flight.

Four principal divisions — Prime Movers, Overhead, Underground and Accident-Prevention—conducted sessions which brought forth some excellent papers on operating problems of interest to all members. Subjects ranged from Combined-Cycle Plants and Boiler Explosions to EHV Transmission.

Richard C. Green, President of the Association (and also of Missouri Public Service), delivered the opening remarks and reported on today's status of investor owned utilities. His talk very ably stated the case for *sensible rate schedules*. It showed the need for basing utility rates on present-day values, rather than on first cost. Realistic rate schedules are required, said Mr. Green, to permit utilities to earn a profit which will induce investors to supply sufficient risk capital to finance the tremendous expansion facing the utilities.

Following Richard Green was John Gammell, Director of Professional Development at Allis-Chalmers. He gave a most thought-provoking talk on the need for proper development for engineers — both technical and personal. According to Mr. Gammell, engineers must concentrate on developing themselves in the fields of liberal arts, more education, and in public affairs. His talk was both humorous and serious—and most interesting.

This excellent conference was under the general chairmanship of Ralph E. Thornton, of Oklahoma Gas and Electric, and certainly showed evidence of fine planning. Conference arrangements were most capably handled by Dale Pettegrew, Director of the Association. Importance of the meeting was evidenced by the large attendance, quality of papers, ability of the speakers, and the large number of manufacturers represented.

A TOTAL OF 45 papers were presented in the three-day Conference. Prime-Movers subjects included: A Combined-Cycle Plant, Boiler Turbine Design Trends, Peaking Power, Computer Operation, Corrosion and Furnace Explosions.

In the Transmission and Distribution category, the subjects covered Overhead and Underground Lines, Pole Inspection and Treating, Conductor Sizing, Transformers, Bundled Conductors, Cables, Load-Control, Computers, Regulation, Economics, EHV, Right-of-Way, Lighting, Codes, and Insulations.

Electrical Apparatus was discussed in papers covering Substation Design Standards, Buses, Circuit Breakers, Relays, and Substation Maintenance. Also, sessions were devoted to Meters, Accident-Prevention and Foreign Systems.

A most pleasant dinner offered one of the highlights of the meeting. Dr. No-Yong Park gave a very entertaining speech, and his talk was followed by some professional entertainment acts.

Value of substation design standards was proved quite conclusively in a talk by D. W. Palmer, of Kansas Gas and Electric Company. Bruce Stout, of Oklahoma Gas and Electric, gave an excellent description of his company's combined steam-and-gas turbine plant. This was unusual in many respects, not the least of which was the lump-sum contract aspect.

William Livingston, of Combustion Engineering, gave his dramatic demonstration of the causes of furnace explosions, using a live model to prove his points. In general, this was an excellent and well-rounded Conference of good practical value to all Association members. **END**

OPTIMIZE FUEL AND POWER COSTS IN SELECTING MAJOR DRIVES

I. H. Landes and D. L. E. Jacobs, of General Electric, show need for economic study

HIGH COST OF FUEL and power demands a well-integrated drive system to optimize these costs and increase over-all profits.

For expansion to an existing plant, electrical and steam systems already in place will influence type of drive selected. In a new design, selection of drives must be considered early in the process planning stages to obtain maximum economies of proper integration into the system.

A typical 50,000-bbl per day oil refinery requires a total of approximately 235,000 lb per hr of process steam at 200 psig, 50 psig, and 15 psig. About 120,000 lb per hr can be obtained from heat recovery equipment in the process area, leaving 115,000 to be furnished from fuel-fired boilers. Approximately 39,000 hp is also required, with the four larger drives rated 7000, 6000, 1500, and 1200 hp. See Table I. Let's consider some alternatives that would fill these requirements.

JUST MOTORS. Electric motors and low-pressure process boilers would call for lowest investment costs, assuming availability of purchased electric power, Fig. 1.

Investment:	
Transformers & Load Centers	$ 760,000
Switchgear & Control	585,000
Motors & Gears	1,280,000
Steam Boilers	1,100,000
Total	$3,725,000

Fuel and Power Costs: Fuel basis is 177 million Btu per hr @ 30 cents. Electricity basis is 25,000 kwh per hr @ 8 mills.

	$/Hour	$/year (8000 hr)
Fuel	53.10	425,000
Electricity	200.00	1,600,000
Total		$2,025,000

Plant distribution system, at 13,800 volts, is supplied directly from two separate utility sources through two transformers of equal rating. This permits operation of the refinery at essentially rated capacity with one source out of service, and maintains optimum reliability.

Sizing of 2400-volt and 480-volt systems is also done with regard to maintenance and operating practices and to consequences of curtailing power on any individual utilization bus. See one-line diagram, Fig. 1.

All alternatives use the same 480-volt system because only drivers above 1000 hp are being compared. However, cost of this system is included in over-all investment costs.

Step-up gears for motor drives have been included in the summary of investment costs. In addition, throttling valves, by-pass lines, inlet guide vanes, and other equipment modifications may be required to obtain process flexibility when using motors. Nothing is included for these modifications.

Cable for the electrical system and steam lines outside the boiler plant are not included because they do not often have a significant effect on cost differentials in a preliminary comparison of alternates.

Automatic extraction turbines are next considered for the two largest drives, 6000 and 7000 hp, and the boilers are raised to 600 psig. For simplification, Fig. 2 omits the pressure-reducing valve which supplies the 200-psig system when the 6000-hp turbine is out of service. Automatic action of the reducing valves and the turbine controls will continuously adust for swings in demand for process steam and shaft power.

Investment:	
Transformers & Load Centers	$ 730,000
Switchgear & Control	560,000
Motors & Gears	830,000
Boilers	1,600,000
Turbines	615,000
Condenser & Cooling Tower	265,000
Total	$4,600,000

Fuel and Power Costs: Fuel basis is 261,000,000 Btu per hr @ 30 cents. Electricity basis is 14,830 kwh per hr @ 8 mills.

	$/Hour	$/Year (8000 hr)
Fuel	78.30	625,000
Electricity	118.65	950,000
Total		$1,575,000

A larger process steam load would increase the attractiveness of turbine drives. In fact, a 60,000-lb per hr increase in 50-psig steam load would decrease the fuel chargeable to power by about $75,000 per year.

TABLE I. ASSUMED REQUIREMENTS FOR 50,000 BBL PER DAY REFINERY

Steam Requirements	Required For Process	Recovered From Process Equipment	Net Required
200 PSIG — 550 F	160,000	110,000	50,000
50 PSIG (SAT.)	45,000	10,000	35,000
15 PSIG (SAT)	30,000	—	30,000
Total (No Feedwater Heating)			115,000

Mechanical Drivers	Installed Capacity	Normal Operating Load
Cat Cracker Main Air Blower	7000 HP	7000 HP
Cat Cracker Main Gas Compressor	6000 HP	6000 HP
Reformer Recycle Compressor	1500 HP	1500 HP
Cat Cracker Transport Air Blower	1200 HP	1200 HP
Miscellaneous Motor Drives (Below 1000 HP)	23,000 HP	14,000 HP

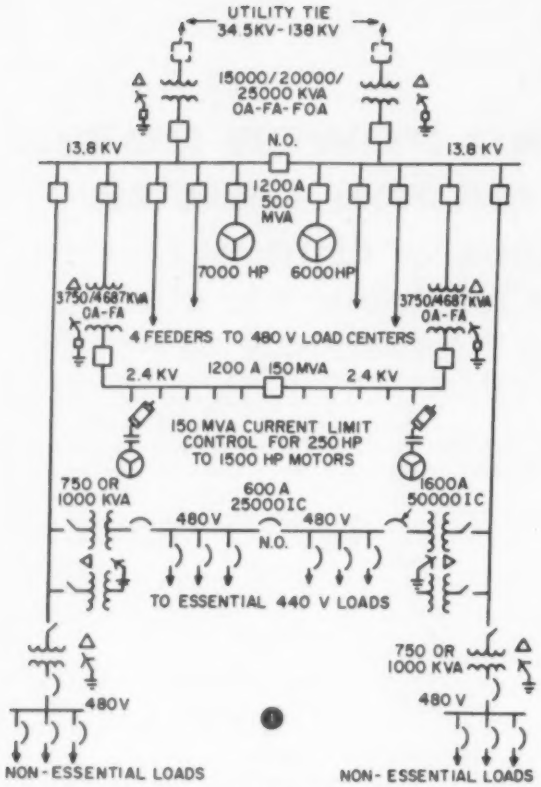
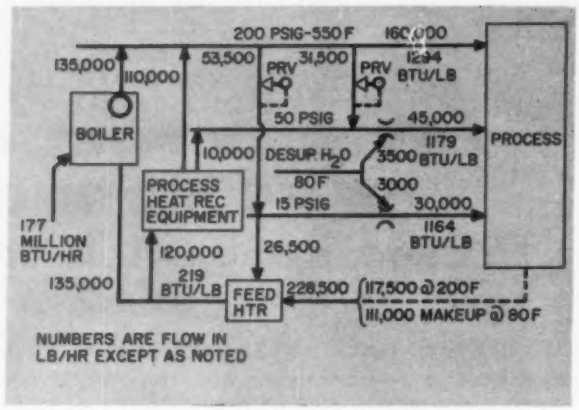


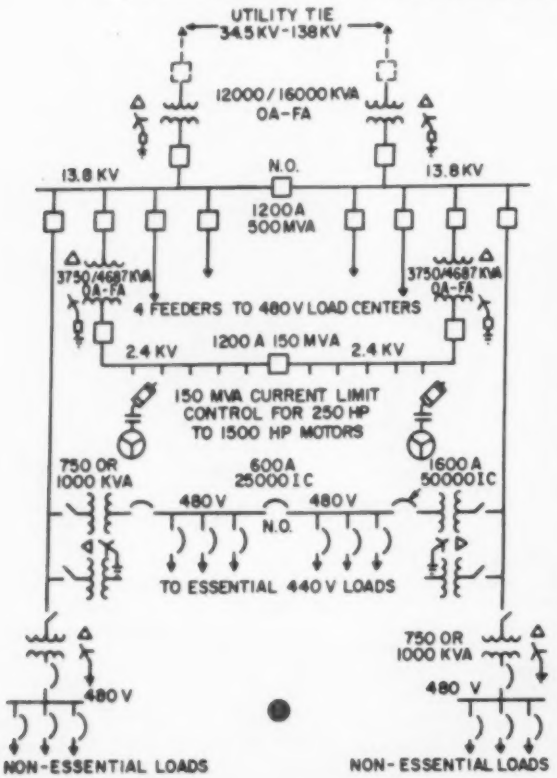
Fig. 1 (Above). Schematic of a steam and electric power system for refinery with all purchased electric power and electric motor drive. Fig. 2. Steam and electric power system for refinery with combination of steam turbines and electric motor drives

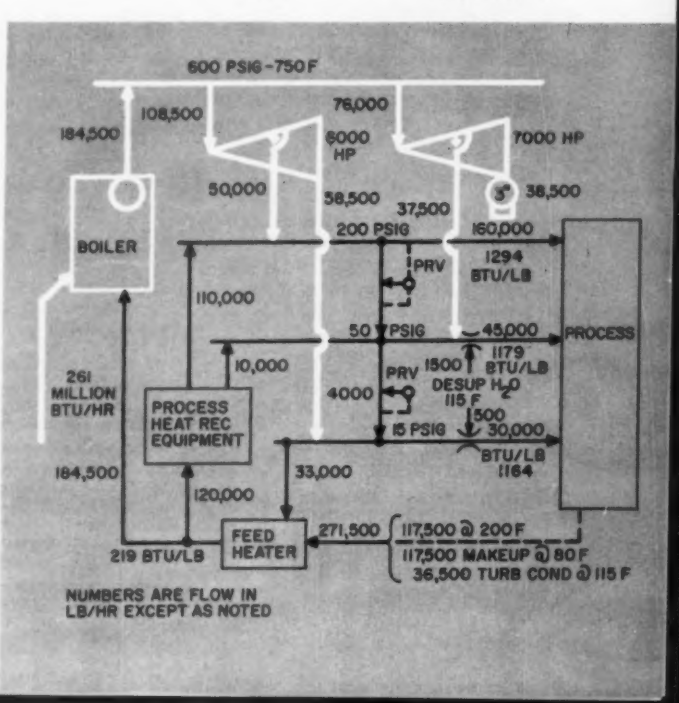


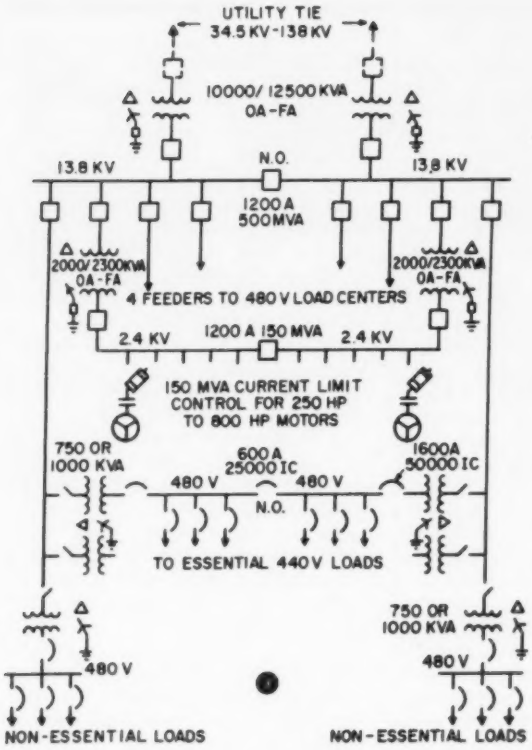
ADD GAS TURBINE. Installation of a gas turbine for the 7000-hp drive is shown in Fig. 3. Exhaust from this turbine is used as preheated combustion air for the 600-psig boiler which supplies the 6000-hp automatic extraction turbine. Non-condensing turbines replace the 1200 and 1500-hp motors.

In this design, steam flow through the pressure-reducing valves is more than 20,000 lb per hr. Care must be taken to be sure adequate flexibility is maintained to handle swings in process steam flow.

Investment:	
Transformers & Load Centers	$ 695,000
Switchgear & Control	545,000
Motors & Gears	740,000
Boiler	1,600,000
Steam Turbines	455,000
Gas Turbine	725,000
Condenser & Cooling Tower	225,000
Total	$4,985,000







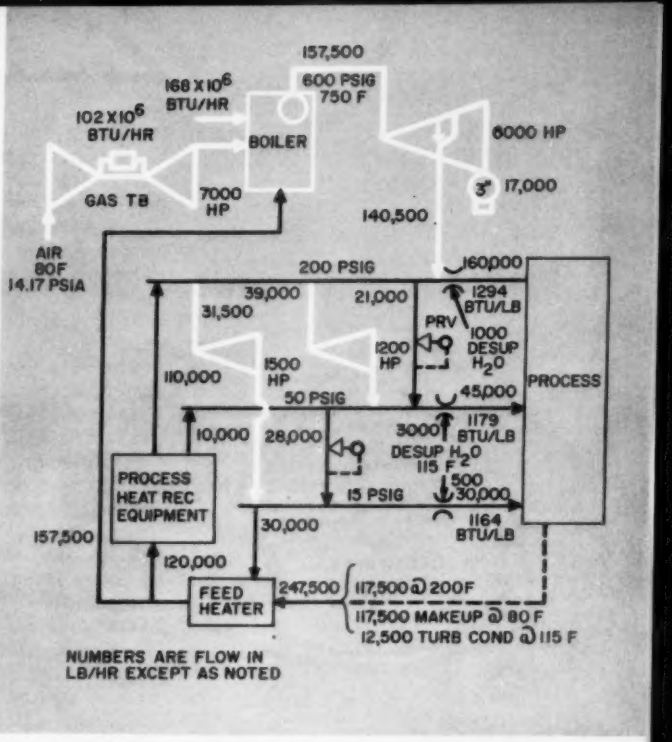


Fig. 3. Steam and electric power system with gas turbine, steam turbine, and electric motor drives

Fuel and Power Costs: Fuel basis 270 million Btu per hr @ 30 cents. Electricity basis 12,150 kwh per hr @ 8 mills.

	$/Hour	$/Year (8000 hrs)
Fuel	81.00	648,000
Electricity	97.20	780,000
Total		$1,428,000

Economics of this alternate would also be improved if more steam were required. Capability of boiler designed to utilize all oxygen in gas turbine exhaust is 75 per cent greater than assumed requirements. More detailed analysis and use of turbine drives for miscellaneous small pumps would increase savings.

SUMMARY. Investment, operating costs and payout are summarized in Table II. Obviously, these systems provide different degrees of operating flexibility. But, for this analysis it is assumed that all three provide acceptable performance and reliability. Assumptions used are straight-line depreciation at 10 per cent, fixed charges 10 per cent, and Federal corporation tax 52 per cent.

Operating labor and maintenance expenses have not been included because there are such wide variations in allocation of these costs.

Alternate 2 shows savings in operating costs so that the added investment compared to Alternate 1 is repaid in 4 years net. This is equivalent to a gross payout of 1.9 years (before fixed charges, depreciation or Federal corporation taxes).

Alternate 3 has a net payout of 4.3 years (2.1 years gross) when compared with Alternate 1. This alternate shows a net payout of 5.35 years (2.6 years gross) for the additional $385,000 investment when compared to Alternate 2.

After the equipment has been fully depreciated for tax purposes, annual savings after Federal taxes is 18 to 20 per cent of initial added investment for either Alternate 2 or 3 compared to Alternate 1.

Proper selection of drives for the major process equipment will have a marked influence on the over-all profits of a plant. Therefore, a thorough knowledge of the capabilities and operating characteristics of the various types of drivers is essential to produce a well-integrated, reliable and economic system.

This study demonstrates, by use of the steam and power system for a new refinery unit, how the savings in operating costs for one process drive system are weighted against the initial investment costs. END

TABLE II. SUMMARY OF INVESTMENTS AND PAYOUTS FOR DIFFERENT SYSTEMS (30¢/MILLION FUEL, 8 MILL/KWH POWER AND 8000 HR/YR)

	Alternate 1	Alternate 2	Alternate 3
1) Investment	$3,725,000	$4,600,000	$4,985,000
2) Fixed Charges (10%)	372,500	460,000	498,500
3) Depreciation (10%)	372,500	460,000	498,500
4) Fuel Cost	425,000	625,000	648,000
5) Purchased Electric Power	1,600,000	950,000	780,000
6) Total Operating Cost	$2,770,000	$2,495,000	$2,425,000
	A2 VS A1	**A3 VS A1**	**A3 VS A2**
7) Savings in Operating Cost	$ 275,000	$ 345,000	$ 70,000
8) Net Savings After 52% Federal Taxes	132,000	165,500	33,500
9) Difference in Depreciation	87,500	126,000	38,500
10) Cash Return (8 + 9)	219,500	291,500	72,000
11) Difference in Investment	875,000	1,260,000	385,000
12) Net Payout (Years)	4.0 Years	4.3 Years	5.35 Years

ISA SYMPOSIUM IN CHICAGO COVERS EXPERIENCES IN POWER CONTROL SYSTEMS

TO SUPPLY the ever-increasing demand for energy, the trend must be toward full integration of all components in power systems into much larger power pools. The ability of men to operate such complex facilities could set a limit to their size, unless timely progress is made in reliable instrumentation and computer control.

Theme of the 4th National Power Instrumentation Symposium was Experiences in Power Control Systems. These papers were delivered:

1. Automatically Controlled Turbine Run-up System, by Denton R. Fenwick, Associated Electrical Industries, Ltd., England.

2. Putting the Digital Computer to Work at the H. B. Robinson (Darlington) Station, by Henry Wachtel, Ebasco Services, Inc., and W. B. Kincaid, Carolina Power & Light Co.

3. A Positive Coal Flow-Air Flow Combustion Control System with Oxygen Control Modification for a Cyclone-Fired Boiler, by D. I. Manter, Public Service Co., and R. R. Tressler, Jackson & Moreland.

4. Satisfying Power Station Chemistry Requirements by Instrumentation, by M. M. Baker, Commonwealth Edison Company.

5. Continuous Analysis of Impurities in Water in Nuclear Power Plants by Flame Photometry, by L. E. Maley, Waters Associates.

6. Analysis of Control Valve Problems in High Pressure Drop Service, by J. R. Bermingham & J. T. Muller, Leslie Co.

7. Data Logging Development & Computer Experiences in Eight Installations of Gulf States Utilities Company, by J. O. Robichau, Gulf States Utilities Co.

8. The Semi-Automatic Plant, by R. F. Scheibel, Sargent & Lundy, Engineers.

9. Power Plant Training at Kodak Park, Frank T. Finey, Eastman Kodak Co.

10. The Application of Transistors, Mag-Amps and Vacuum Tubes in Power Plant Instrumentation, by J. L. Cockrell and E. W. Voorhoeve, Leeds & Northrup Co.

11. Experiences with Flame-Failure Detectors on Large Coal-Fired Steam Generators, by J. W. Wanless, A. E. Featham and L. J. Simpkin, Detroit Edison Co.

12. New Tools For Safeguarding Utility Boiler Furnaces, by R. R. Beal, Bailey Meter Co.

13. Operating Practices Conducive to Safe Boiler Operation, by E. C. Mornhinweg, Texas Electric Service Co.

Mr. Fenwick recognized the widely held opinion that the future of large thermal-electric generating station control lies with the solid state digital computer. However, he believes that the large capital cost involved will make widespread application unlikely until pilot installations have been time-proved.

ACTRUS was the first experimental installation put into operation at the Agecroft Power Station of the Central Electricity Generating Board, Great Britain. It has shown itself to be particularly successful in handling both cold and hot run-ups of one of the existing 120-Mw, 300-rpm, 1500-psi, 1000/1000 F reheat machines. Routine operations such as raising vacuum, starting oil pumps, etc., were carried out manually.

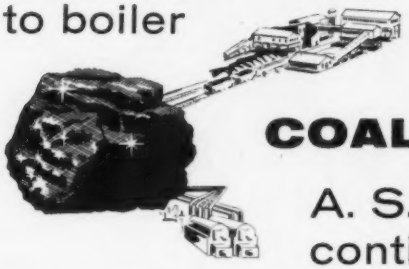
MR. WACHTEL discussed the problems involved in Putting the Digital Computer to Work. Problems are partly due to computer limitations, and partly due to need for further knowledge about plant dynamics and measuring techniques.

An example of the fundamental nature of the investigation necessary may be given in reference to interpretation of data. It must first be verified that the frequency of averaging does not of itself introduce errors in performance calculations. A 20-second averaging period was found suitable for all variables except feedwater flow, which cycled at a period close to 20 seconds. Hence, a 5-second period was chosen for feedwater flow averaging.

Mr. Robichau concluded that cost experiences over a five-year period have confirmed the original premise of more economical power production. Gulf States Utilities Company feels justified in continued application of automatic data-handling systems, as well as any other new methods substantiated by reasonable evaluation.

A very encouraging picture of flame-failure detection was presented by Mr. Wanless. With a combination of lead sulphide and ultraviolet detectors, satisfactory performance was obtained, and no false trips have as yet been initiated by the detection system. On the basis of this experience, Detroit Edison is in the process of installing similar systems on additional units. END

Coal—from mine to boiler



COAL STORAGE AND RECLAIM

A. S. Drummond, of Detroit Edison, continues his story of how an electric generating utility handles, processes and uses coal

WHERE COAL STORAGE facilities are remote from the dock, and belt feeding to the storage area is not feasible, stocking out and reclaim is accomplished by use of railroad cars and locomotive cranes. Figure 2 shows the stocking out of coal from a gondola car. A coal storage yard stocked by this means is shown in Fig. 1. The distance between tracks controls the width of the piles and this distance is established by the extent of bulldozing that can be justified and the length of the crane boom.

Figure 3 shows reclaiming of coal to hopper bottom railroad cars using a bulldozer to move the coal to where it can be picked up by the clam shell bucket of the crane.

Modern plants of large capacity may burn several million tons of coal a year and require stocking in excess of a million tons. Conveying systems and mobile type of bulk-moving equipment with storage areas near the plant are essential for handling these volumes. Coal is conveyed from the receiving point to a stacker. Two types of stackers are shown in Figs. 4 and 9.

The traveling stacker piles the coal in a long pile parallel to its travel whereas the swiveling stacker piles the coal in a kidney-shaped pile. Bulldozers are used to break down

Fig. 1. Coal storage area served by railroad facilities. Distance between tracks controls width of the piles

Fig. 2. Locomotive crane stacking coal from a gondola car. Yard stacked by this means is shown in Fig. 1

Fig. 3. Reclaim of coal from storage using railroad facilities and dozer

the stacker pile and Fig. 6 shows a bulldozer climbing a pile preparatory to doing this. The bulk-moving equipment will then be able to ride over the pile for loading.

Equipment shown in Fig. 5 is especially suited to situations where it is necessary to move the dozing equipment from one location to another over public roads. Figure 7 shows mobile bulk-moving equipment loading from the stacker pile, and in Fig. 8 one of these units is seen with the gate up during the loading operation. In some cases, loading of this mobile equipment, bottom dump trucks or other types is accomplished from overhead bins through bottom gates.

In the process of building up the storage coal area, Figure 10, the operation of these large mobile units over the coal compacts it and limits oxidation which greatly reduces the possibility of fires due to spontaneous combustion during the storage period.

Reclaim may be accomplished with the same equipment bottom-loading off the storage pile. The coal is fed

Fig. 4. Traveling stacker piles the coal in a long line parallel to its travel

Fig. 5. Rubber-tired bulldozer

into the conveying system through yard reclaim hoppers or the unloading house.

In some installations, yard hoppers are used to provide live storage for the plant by piling the coal over the hoppers. The coal is fed by gravity through the hoppers whenever the conveying system is in operation. The coal in the area above the hoppers is replenished during the regular work period with the mobile equipment. END

Fig. 6 (top). Dozers are used to break down stacker pile. Fig. 7 (center) shows mobile equipment loading from stacker pile. Fig. 8. Gate is up during the loading operation

Fig. 9. Swiveling type of stacker deposits coal in a kidney-shaped pile

Fig. 10. Large mobile units operating over coal compact it, limit oxidation

POWER AUTOMATION DEVELOPMENTS REVIEWED IN SYMPOSIUM

SOME OF THE TOP automation experts in the U.S. and Great Britain were guests of POWER ENGINEERING's editors recently at a dinner session in Chicago. Purpose of this meeting was to review the developments to date in power plant automation and to learn what the experts are planning for the future.

Guests attending the dinner meeting were: C. H. Barnard (Bailey Meter), Harry Bauer (Beckman), Frank Battuello (G.E.), Thomas Bloodworth (Allis-Chalmers), Nathan Cohn (Leeds & Northrup), Jack Delk (RCA), Carl Fleming (Foxboro), Charles Giles (So. Calif. Edison), L. W. Meier (Bechtel), Paul Miller (Daystrom), Thomas Nourse (Hagan), J. O. Robichau (Gulf States), Don Sauter (Westinghouse), A. J. Schager (Cleveland Electric), C. C. Schonhoff (TVA), Charles Smoot (Republic), Wm. Summers (Ebasco), Henry Wachtel (Ebasco), J. J. Walsh (Sargent & Lundy), J. Hunnicutt (T-R-W), Martin Lyford (RCA) and George Fowle (Leeds & Northrup).

Editors hosting the group were Dick Morris, Bob McCaw, Andy Kramer, Chester Earle, John Tyner and John Papamarcos. Several of the people were unable to be present; these were: C. H. Taylor (Brown Instruments), L. F. Kennedy (G.E.), Henry Bechard (T-R-W) and T. Yamashita (Bendix). Attending as a foreign guest was Denton Fenwick, of Associated Electric Industries, Ltd., Manchester, England.

This was the second affair of this nature conducted by POWER ENGINEERING; the first was held during the time of the American Power Conference, in 1960. Many of those attending this year's dinner were present at last year's meeting. Also, many had been authors of a special edition on "Automation in the Power Field" — published in POWER ENGINEERING in January 1960.

Representing engineers, manufacturers and users, this cross section of the power automation field compared notes on design versus operation, and discussed some of the valuable lessons being learned in adapting computer operation to power plants. For instance, in making flow charts, prior to setting up programs, every piece of equipment must be carefully screened as to its vital necessity in the cycle.

Mention was made of one plant, which was being studied for computer operation, in which a "justification study" proved that 28 valves could be eliminated from the steam cycle. Since most of these were expensive, motor-operated valves, the resultant savings was a considerable item.

Some highlights of the discussion were these:

(1) System reliability for complete computer operation must be 99.99 per cent.

(2) *Full* automation prevents manual operation of any single component, in case of trouble, which can be quite serious.

(3) About 50 per cent of all big plants, now under design by one company, will be computer-operated. (These plants will be completed after January 1, 1963.)

(4) Computer - Program studies are bringing to light the causes of many plant problems of long duration. (Users will eventually profit by this extensive research, regardless of automation.)

(5) Some automated plants have experienced "noise" in some circuits, and the owners have been forced to use extensive shielding of control cables—to keep out stray d-c impulses.

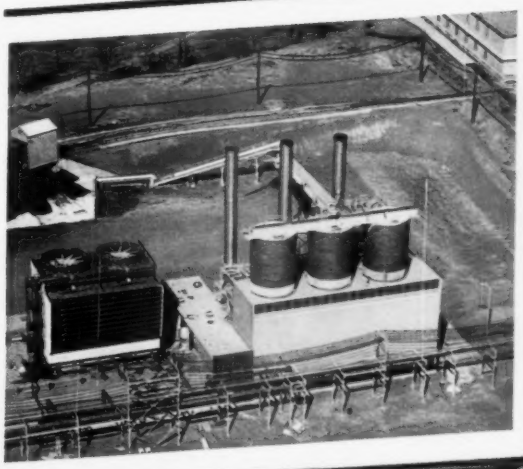
(6) Thought must be given to the "human experience" factor—in computer - controlled plants. (It is possible that future plant operators might never gain the basic training which has been acquired by operators in the past.)

(7) It was agreed that one plant automation project will require from 10 to 30 man-years to completely program and complete the automation.

(8) Timing gear and steam seals are the most critical items to consider on automatic startup. Both are difficult to program.

Most of the guests were attending the ISA Power Instrumentation Symposium. Because of the value gained from this meeting, it was agreed that future sessions would be held. The group immediately assumed the important-sounding title of "The Automation Committee for Advanced Power Engineering Technology." END

STEAM, AIR & ICE FOR BILLIONS OF PACKS



Stone & Webster Engineering Corporation has recently completed a facility to provide process steam, refrigeration and compressed air for R. J. Reynolds Tobacco Company's new 13½ acre cigarette plant at Winston-Salem, North Carolina.

This is one of the largest refrigeration facilities of its type in the world. The three-unit system has a capability of 2,700 tons, while total installed steam capacity rates at 300,000 lbs per hour. The new Whitaker Park plant will increase Reynolds' production about one-third.

In designing and constructing the process steam and refrigeration facility, Stone & Webster's ability and experience in this field produced substantial savings for the client.

We would welcome an opportunity to explain in detail how we can serve you.

STONE & WEBSTER ENGINEERING CORPORATION

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new power construction

Anchorage, Alaska—Department of Public Utilities, City Hall, has approved plans for expansion and improvement in municipal power plant, including the installation of a gas turbine electric generating unit along with auxiliary equipment. Work will begin at once on the new installation which will cost about $2,024,000 before completion in 1963.

Page, Ariz.—United States Bureau of Reclamation, Denver, Colo., has announced contract award to the General Electric Company, Schenectady, N.Y., for construction and installation of eight giant generators for the Glen Canyon Dam powerhouse now under construction near here. Two other firms submitted bids slightly under that of G-E, but the bid of $8,007,798 was designated the low bid because the company plans to manufacture the generators in Schenectady, N.Y., which has been designated a labor distress area by the Department of Labor.

Denver, Colo.—Bureau of Reclamation, Department of the Interior, Building 1-A, this city, ha announced contract award of $3,335,243 for construction of a 200-mile transmission line between Sioux City and Spencer and from Sioux City to Creston by way of Denison, Iowa. Project is part of Missouri River Basin Project. Work will start at once and will be completed by the fourth quarter of 1962.

Urbana, Ill. — Board of Trustees, University of Illinois, Administration Building, has approved plans for extensions and improvements in the University's Abbott Power Plant. Plans include the installation of equipment for increased generating capacity, and work will begin at once. Cost of proposed expansion is reported to be about $650,000.

Indiana Harbor, Ind.—Inland Steel Co., 38 S. Dearborn St., Chicago, Ill., has authorized plans to construct a new foundry for casting the molds used in making steel ingots, and a large new plant for production of electric power and steam. Both projects at this location are to be started soon and are scheduled for completion by the summer of 1963. New foundry, which will turn out about 150,000 tons of molds annually, will enable the company to supply molds for its steelmaking operation at a considerable savings and will employ about 170 workers when in full production.

Cedar Falls, Iowa—City Municipal Utilities Commission, City Hall, 612 E. 12th St., this city, has authorized plans for expansion of the municipal power plant here and will install new equipment for increased generating capacity. Plans call for installation of a new steam electric generating unit with an initial capacity of 16,500 kw along with necessary auxiliary equipment. Cost of the new installation will be approximately $3,925,000 when completed. Work will begin at once and is scheduled for completion late in 1962.

Big Rock Point, Mich.—Consumers Power Co., Jackson, Mich., and the General Electric Co., Schenectady, N.Y., have announced that work is progressing according to schedule on the construction of a nuclear power plant on a large site on Lake Michigan in Charlevoix County. The $28,000,000 project will have an initial capacity of 50,000 kw and is scheduled for completion by late 1962 or early spring of 1963.

Fergus Falls, Minn. — Otter Tail Power Co., headquartered in this city, has announced plans for a major expansion and improvement program of its system. Plans include the installation of a new steam electric generating plant with an initial capacity of 66,000 kw to the company's system at a cost of $12,000,000. The facility, which will increase company's generating capacity by about 35 per cent, will be built at either this location or at Ortonville, Minn.

Minneapolis, Minn. — Northern States Power Co., 15 South Fifth St., has authorized plans for a major expansion and improvement program of its transmission system to get under way at once. Work will include a substation and 34,500-volt transmission line at Wakefield to cost approximately $500,000; an electric substation with transmission lines, 13 miles west of Tracy Lyon County, at about the same cost; and an electric substation at Scandia and feeder lines between it and Lindstrom, Minn., at an approximate cost of $136,000. Other work on the improvement of transmission lines and substations also is planned at a reported cost of about $2,000,000 in other parts of the company's service area.

Omaha, Nebr.—Omaha Public Power District, Electric Building, has announced plans to expand its system with installation of equipment for increased generating capacity. Plans include installation of a fourth generating unit at the North Omaha Station with an initial capacity of 125,000 kw. Company plans to enter the bond market to finance the project, which will cost an estimated $2,000,000. Work will probably get under way early this fall and will be completed by the summer of 1963.

Dover, N. J.—New Jersey Power & Light Co. has announced completion of the $200,000 renovation and expansion program of its McFarlan Street Northern Division headquarters here. Property was recently augmented to meet expanding administrative, engineering, sales and civic purposes in the area, which serves a region extending from the Delaware River on the west, the New York State line on the north, Pluckemin on the south, and Mountain Lakes on the east.

Buchanan, N. Y.—Consolidated Edison Co., 4 Irving Place, New York, N.Y., has announced that the $100,000,000 atomic-powered generating plant, now under construction on a 350-acre site at this location on Indian Point on the Hudson River, below Peekskill, N. Y., will not start testing the plant's output until late this fall, due to a jurisdictional strike with the union. Under a new timetable, the $17,000,000 core for the reactor, which is eight feet long and six feet in diameter, will be installed in the fall of this year. Core will last 600 days on a continuous basis or 1200 days on a normal schedule. Company now anticipates full operation of the 275,000-kw unit by early 1962, enough for the needs of 1,000,000 people in the metropolitan area.

Island Park, N. Y.—Long Island Lighting Co., 250 Old Country Road, Mineola, Long Island, New York, has plans under consideration for the expansion of the local generating plant. Plans call for the installation of a second generating unit with an initial capacity of 185,000 kw at existing plant here, known as the E. F. Barret Power Station. Work is not scheduled to begin until the spring of 1963, and it is estimated that the plant will require a period of two or more years for completion. Cost of the new facility in terms of today's estimates was reported to be between $30,000,000, and $40,000,000.

Oklahoma City, Okla. — Oklahoma Gas & Electric Co., 321 Harvey St., has announced that it will begin construction soon on the initial 30-mile section of a high-voltage transmission

This simple trap operating principle provides the efficiency, dependability and freedom from maintenance necessary for the most profitable use of steam

When trap is first installed, the inverted bucket is down and the valve is wide open.

When steam is turned on, condensate (solid color) flows into trap and out through discharge orifice, until —

Steam (light color) reaching the trap floats the inverted bucket and closes the valve.

When more condensate enters the trap, the bucket loses buoyancy and pulls on valve lever.

When weight of bucket times leverage overcomes pressure on valve, bucket sinks and opens trap.

Key: condensate steam steam bubbles air bubbles

ARMSTRONG INVERTED BUCKET STEAM TRAPS

are designed and made to give you these big benefits:

Armstrong Traps, the first inverted bucket steam traps, now represent the most advanced development of this time-proven principle. They provide all the advantages necessary for efficient, economical condensate drainage from virtually all types of steam using equipment.

1. *No steam loss* – Steam never reaches the orifice even when there is no condensate load.
2. *Automatic air elimination* – Vent in trap bucket passes air and other non-condensibles through to be discharged with condensate.
3. *No cooling leg required* – Condensate is discharged at steam temperature as fast as it reaches the trap because trap operates on difference in density between steam and water not on temperature.
4. *Operates on any back pressure* – Failure of one trap in system will not cause others to open because high back pressure does not affect an Armstrong trap other than to reduce capacity. As long as there is a pressure differential across the orifice the trap will close on steam and open for condensate.
5. *Unaffected by ordinary dirt* — Swirling action of condensate keeps dirt in suspension until discharged with condensate, prevents it from lodging in valve.
6. *Completely dependable* — Proved design plus the use of all stainless steel working parts assure continuity of service and length of service unmatched by any other trap.
7. *Big capacity in a small, economical package* — Armstrong design gives you the highest practical capacity for any given pressure. And remember, Armstrong capacity ratings are based on *hot* condensate at the *working pressure differential* stated, not on theoretical orifice capacities.

Further information on these advantages plus much additional information is given in the 48 page Armstrong Steam Trap Book. Ask your local Armstrong Representative or write direct.

860 Series for low pressure heating service.

800 Series, side inlet, side outlet.

No. 801, side inlet, bottom outlet.

880 Series, integral strainer.

200 Series, bottom inlet, top outlet.

Forged Steel Series for high pressures, high temperatures.

The 48 page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.

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line in conjunction with a group of investor owned utilities which plans a network of extra-high-voltage transmission lines linking an eight state area in the Southwest. It was estimated that the grid would cost more than $300,000,000 and would be designed for initial operation at 345,000 volts, with provisions for enlargement to 500,000 volts. By contrast, the regular high-tension lines common to country areas operate at 132,000 volts. The grid will eventually extend from Omaha, Nebr., in the north to the Gulf of Mexico and from Jackson, Miss., west to the western border of Texas.

Knoxville, Tenn.—Tennessee Valley Authority, New Sprankles Building, headquartered in this city, has announced that the authority has under construction or in the design stage, additions to its power transmission system representing an investment over $60,000,000. Additions and improvements are needed to meet the rapidly growing power loads in its service area. Largest of the projects, costing an estimated $8,000,000, comprises two 161,000-volt transmission lines to connect to the system the 500,000-kw steam turbine-generator now being installed at Colbert Steam Plant in the northwestern part of Alabama. One line is now under construction from Colbert to Cullman, Ala., and the other will go from Colbert to Columbus, Miss.

Richland, Wash. — Atomic Energy Commission, 1901 Constitution Ave., N.W., Washington, D.C., through the Hanford Operations office, has announced plans for the construction of what will be the world's largest atomic power plant at this site. By converting a plutonium-producing reactor (now under way) to generate 700,000 kilowatts of electricity, the Kennedy Administraion has decided to turn the Hanford Works reactor into a dual purpose plant — producing plutonium for atomic weapons and generating electricity for consumers in the Pacific Northwest. Power from the reactor, which will have a generating capacity greater than the Bonneville Dam, will be sold at conventional rates. The reactor is scheduled for completion by late 1962 and the power plant about the fourth quarter of 1964.

Seattle, Wash.—Puget Sound Power & Light Co., White - Henry - Stuart Building, has plans under way on the construction of a 131-mile power transmission line from Wenatchee to Auburn, Washington. Project will include the erection of a receiving substation at the Auburn end of the line. Work on the power transmission line is already under way under supervision of Stone & Webster Engineering Corp., also of this city, and the consulting engineer of the project. A target date sometime in the fall of 1962 has been set for completion at a total cost to be over $7,000,000.

around the power circuit

Continued from page 6

plant on the Colorado River in northern Arizona. The contract goes to General Electric Co., for manufacture at its plant in Schenectady, N. Y. Schenectady's labor surplus classification was a major factor in the award, inasmuch as two bids for foreign manufacture were lower than the domestic GE bid before evaluation.

The eight Glen Canyon generators will be the largest in capacity ever installed by the Bureau of Reclamation in the Western States. General Electric contracted to furnish, install, and test eight 125,000-kva, 90 per cent power factor, 13,800-v, 150-rpm, 60-cycle, vertical-shaft, hydraulic-turbine driven, alternating-current generators. The eight-unit power plant will have a total installed generating capacity of 900,000 kw.

FPC has approved the merger of Connecticut Light and Power Co., of Berlin, Conn., and Housatonic Public Service Co., of Derby, Conn. Connecticut Light and Power will be the surviving corporation.

EXTENSIVE ADDITIONS to TVA's power transmission system are under way. When completed, these additions will cost approximately $60 million. About one-third is for projects now under construction; the balance is for projects in the engineering stage.

Largest of the projects under construction, to cost an estimated $8 million, comprises two high capacity, 161,000-v transmission lines to connect the 500,000-kw steam turbine-generator now being installed in the Colbert Steam Plant in northwest Alabama. Total length of the two lines is 174 miles.

NEW selective bibliography listing U.S. Government research reports, translations, and other technical documents on fuel cells and related research has been published by the Office of Technical Services, Business and Defense Services Administration, U.S. Department of Commerce, Washington 25, D.C. The bibliography is available from OTS for 10 cents.

WEST PENN POWER CO. plans to spend over $86 million in the next three years on a construction-expansion program. Biggest item is the new 250,000-kw unit at Mitchell power station on the Monongahela river, near the city of Monongahela. The unit is scheduled for operation in the late summer of 1963.

Other major categories in the program are: $29,518,700 for distribution substations and lines; $6,493,600 for new equipment, such as large capacity transformers, oil circuit breakers, and regulators for substations, plus new service buildings and the remodeling of present structures; $5,922,600 for transmission substations and lines.

INVESTIGATIONS in to the possibilities of linking up the Swedish, Norwegian, and Danish power transmission system with the Continent are at present going on under the working name of Konti-Skan. A committee with representatives from Sweden, Norway, Denmark, and West Germany is engaged on the project.

The power exchange system between the Nordic countries already built up or decided upon covers Norway, Sweden, Finland and the Danish Island of Zealand. When completed in 1963, the total annual power production within this area will be close to 100,000 million kwh, Sweden accounting for 43,000 million, Norway for 38,000 million, Finland for 12,000 million, and Denmark, i.e. Zealand, for 3000 million.

LEASE for a 45,000-square-foot exhibit site at the New York 1964-1965 World's Fair has been signed by the Fair Corporation and Power & Light Exhibit, Inc., which is administering the participation of the investor-owned electric utility industry at the Fair. The P&LE exhibit will occupy a corner site near the lagoon on two of the Fair's principal traffic arteries.

AN ADDITIONAL 325,000-kw steam turbine-generator has gone into operation at Detroit Edison's St. Clair Power Plant, bringing total capacity at St. Clair to 1,350,000 kw.

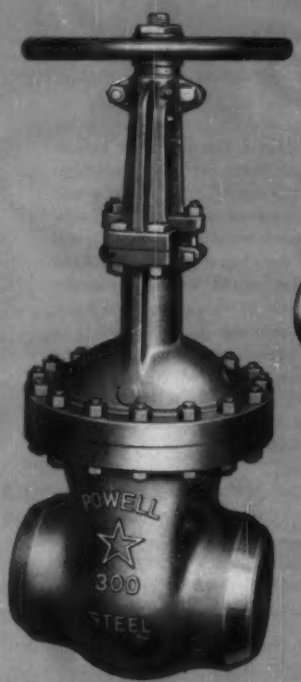
YOU CAN COUNT ON POWELL VALVES

Performance proves it, year after year—you can count on Powell Valves to help you solve the toughest flow control problems of temperature and pressure found in power plants today.

This truly dependable performance results from many things—among them Powell's engineering know-how, accumulated during 115 years of valve manufacture, and the consistent use of quality materials, quality controlled.

Then, too, you can count on getting the Powell Valve you need, when you need it. That's because Powell maintains a network of distributors backed up by factory inventories, warehoused "ready to go."

Get the full story from your nearby Powell Valve Distributor, or write us direct . . . The Wm. Powell Company, Cincinnati 22, Ohio.



300-pound Steel Gate Valve—Fig. 3003 WE. Bolted flanged yoke-bonnet. Outside screw rising stem. Interchangeable solid or split wedges, renewable seats. Sizes, 1" through 30".

600-pound Steel Horizontal Swing Check Valve—Fig. 6061 WE. Bolted cap, renewable seat and disc. Has full flow area when valve is fully open.

2500-pound Steel Pressure Seal Gate Valve—Fig. 125003 WE. Enclosed bevel gears facilitate operation. Valves can also be supplied with spur gearing or motor operators for remote control.

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ATOMICS

. . . a new quarterly magazine will cover nuclear energy development and research from the standpoint of engineers—men just like you—having a direct interest in the practical applications of atomic energy for their own companies.

Editorial coverage of ATOMICS will include the following classifications: Basic nuclear science; Nuclear research and development; Nuclear reactors; Nuclear power systems; Instrumentation and control; Nuclear fuel technology; Health physics and radiation safety; Buildings, structures, and site development; Production and application of radioisotopes; Biological aspects; and, Use of radiation in industries.

ATOMICS will be edited for those in industry whose work brings them in close relationship with nuclear activities but who are not specially trained in nuclear science. The new magazine will be international in scope; it will bring you reports of developments in the field of nuclear energy the world over. Subscribe now and take advantage of this service to keep abreast of the swift-moving developments in the exciting field of atomic energy.

Fill out this application form, cut-out and mail today. To insure receiving the first issue in July 1961, enclose $5.00 with this form and we will extend your subscription through 1962 as a charter subscriber.

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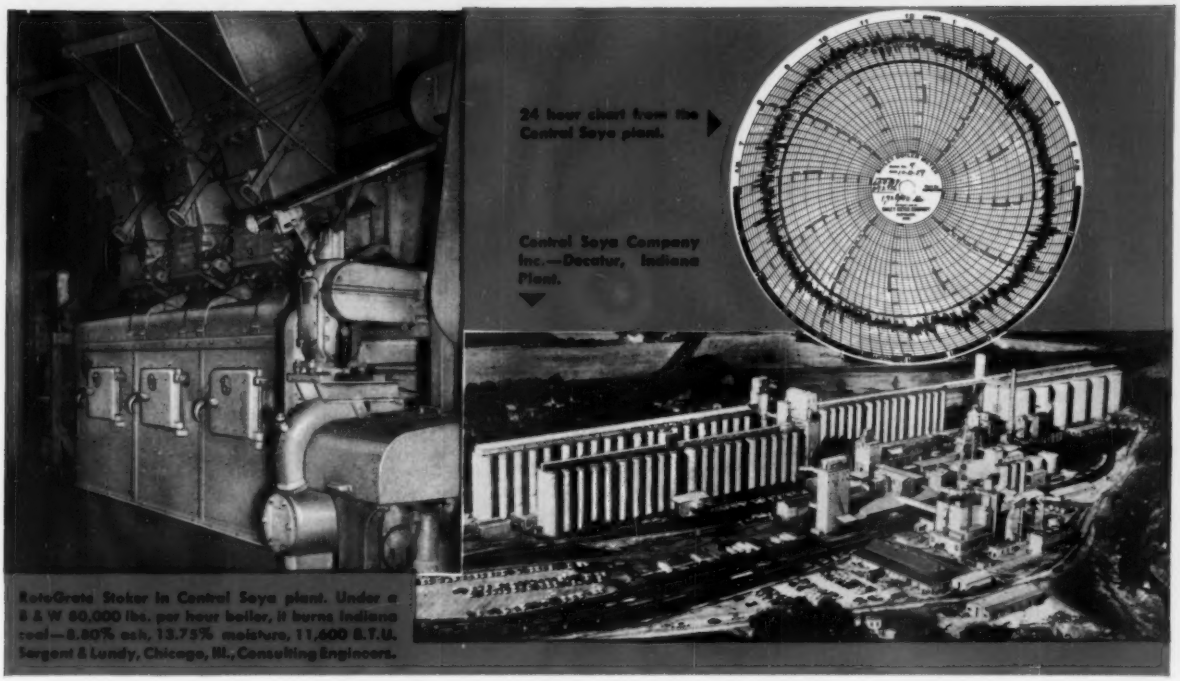

RotoGrate Stoker in Central Soya plant. Under a B & W 80,000 lbs. per hour boiler, it burns Indiana coal—8.80% ash, 13.75% moisture, 11,600 B.T.U. Sargent & Lundy, Chicago, Ill., Consulting Engineers.

8 Years of Stoker Operation
Without Forced Outage

DETROIT ROTOGRATE AVAILABILITY AT CENTRAL SOYA COMPANY INC.

Hersel Nash, Steam Power Superintendent of Central Soya Company, Inc., Decatur, Indiana Plant says: "Our 80,000 pounds per hour, 600 psig boiler with Detroit RotoGrate Stoker has carried loads similar to the accompanying chart for 355 days per year for eight years (we have the boiler down for inspection and cleaning once each year, for about 10 days.)"

"During this time we have burned about 300,000 tons of Indiana coal without ever losing the load because of the stoker. Our monthly efficiencies average 85% to 86%. This is above the manufacturer's predicted performance."

This 'round the clock—seven days a week operation year in and year out with high economy proves the rugged stamina and ability of the RotoGrate . . . shows why it has long been first choice among operators and top management alike.

Built to serve steam generators up to approximately 400,000 pounds steam per hour capacity, the RotoGrate is one in a complete line of Detroit Stokers . . . overthrow spreader and underfeed types for commercial, industrial and utility boiler plants—also for incineration of both municipal and industrial wastes.

DETROIT STOKERS COST LESS Cost equals initial investment plus upkeep, plus production losses due to equipment outage. *The total is less with Detroit.* Ask for Bulletin.

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The modern TUBE CLEANER

Fast • Powerful • Efficient

Only ROTOJET Tube Cleaners offer the simple, efficient, time-tested Rotocentric design. A single paddle maintains contact with the cylinder wall without depending upon centrifugal force. Motor won't stall at low speeds caused by heavy loads. Positive starting is assured with Rotojet motors driven by air or steam.

Rotojet water-driven Tube Cleaners are comparable in speed and power with air-driven types.

Send for bulletin showing motors, heads, and brushes for straight and curved tubes and pipes from ½" to 12" I.D.

Section of ROTOJET pneumatic motor showing simple design.

PNEUMATIC

Model C-525 ROTOJET Air-driven Motor with swing-frame head and universal coupling for 2¾" to 3½" I.D. curved tubes.

Model S-530 ROTOJET Air-driven Motor with swing-frame head for 3¼ to 3-13/16" I.D. straight tubes.

Model C-526 ROTOJET Air-driven Motor with single pin head and universal coupling for 1¾" to 2½" I.D. curved tubes.

Model C-434 ROTOJET Junior Air-driven motor, flexible holder, expanding brush.

HYDRAULIC

Model C-322 ROTOJET Water-driven Motor with 3-arm head and universal coupling for 2¼" to 2½" I.D. curved tubes.

Model S-360 ROTOJET Water-driven Motor with combination drill head and universal coupling for 3¼" to 3⅞" I.D. straight tubes.

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new engineering books

Mechanical Measurements, by T. G. Beckwith and N. Lewis Buck; 559 pages, 6¼ by 9¼ in., cloth bound. Published by Addison-Wesley Publishing Co, Inc, Reading, Massachusetts. Price $8.75.

Designed as a test and reference for both classroom and laboratory sessions at the advanced undergraduate level, this book provides a comprehensive introduction to modern measurement techniques for students of mechanical engineering.

Part 1, Fundamentals of Mechanical Measurement, approaches the problem from a general standpoint, dividing measuring systems into functional groups, considering basic standards, introducing dynamic response, and discussing fundamental system elements and definitions.

Part 2, Applied Mechanical Measurement, applies the technique to specific mechanical quantities, such as displacement, strain, force, pressure, and acceleration. While electrical systems are adequately covered, most of their components are treated only in terms of their functional characteristics.

The book is written with the assumption that the reader possesses a good general background in the elements of mechanical engineering, including the usual engineering mathematics through differential equations.

A rather extensive list of references is appended.

Flow Meter Engineering Handbook, compiled and edited by C. F. Cusick; 170 pages, 8 by 10½ in., cloth bound. Published by Brown Instruments Division, Mail Station 0280, Minneapolis-Honeywell Regulator Co, Wayne and Windram avenues, Philadelphia 44, Penna. Price $7.50.

In this third edition, basic data have been rearranged, and the scope has been expanded to include information on primary devices other than orifice plates.

Schematic diagrams, graphs, charts, tables and other data are included, with separate chapters on steam, liquid and gas flow. Superheated steam factor tables have been expanded to include gage pressures up to 3000 psi.

Three solutions to a flow problem

The LGP-30 Electronic Computer begins breaking up figure-work bottlenecks the very same day it is delivered.

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are outlined in each chapter: an approximation check, a nominal orifice bore calculation, and a precise orifice bore calculation.

Nomenclature used in the handbook is approved by major instrument manufacturers, and, where applicable, agrees with ASME and AGA fluid meter reports.

Proceedings of The National Conference on Water Pollution, U.S. Dept of Health, Education and Welfare, Public Health Service; 607 pages, 6 by 9⅛ in., paper cover. Published by U.S. Government Printing Office, Washington 25, D.C. Price $2.25.

This volume presents the official proceedings of the National Conference on Water Pollution, called at the request of President Eisenhower and held in Washington, D.C., in December 1960.

Eight chapters comprise the volume, with seven devoted to individual sessions and the eighth to a summary of recommendations.

Participants took part in four panels:

Panel I—Water pollution and our changing times.

Panel II—Meeting the growing competition for water.

Panel III—Keeping water clean.

Panel IV—Research and training.

Three appendixes are provided, the first consisting of additions made to the record, the second listing exhibits and film showings, and the third naming the more than 80 conference participants.

Manual on Industrial Water and Industrial Waste Water, 1960 printing of the second edition, 1959; 658 pages, 6¼ by 9¼ in., cloth bound. Published by the American Society for Testing Materials, 1916 Race St, Philadelphia 3, Penna. Price $11.

In this new printing of the Manual's second edition-1959, Part II, on ASTM Standards, has been enlarged and brought up to date by the inclusion of the new and revised methods and definitions issued in 1960. There have been no changes in Part I, on general uses and problems of sampling and analysis.

Boilers, by Carl D. Shields; 559 pages, 6 by 9 in. Published by F. W. Dodge Corp, New York. Price $15.

Here is a really practical, and all-inclusive, roundup of boiler information. The book is devoid of all the usual steam tables and mathematics readily available in

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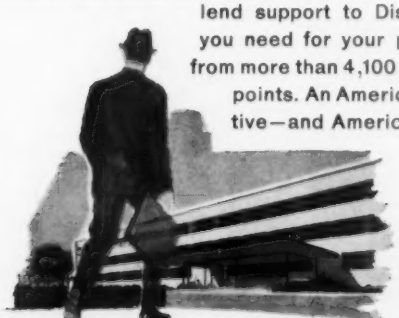

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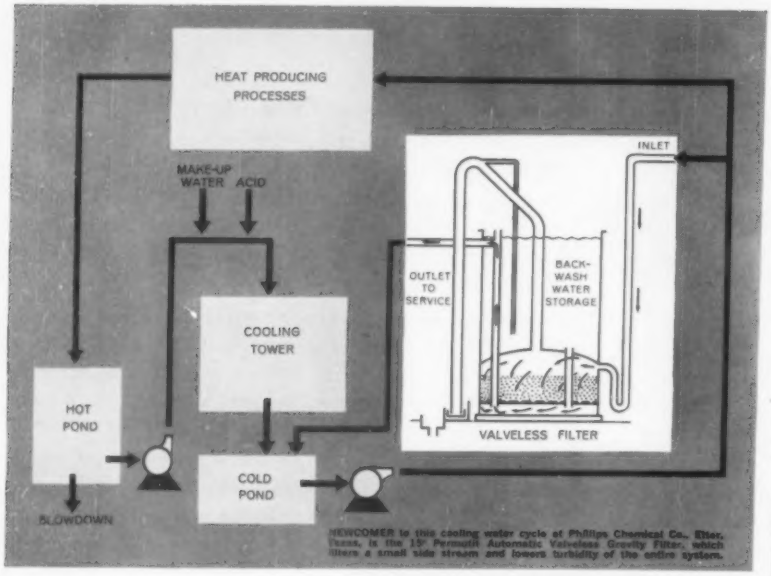
FLUIDICS* AT WORK



NEWCOMER to this cooling water cycle of Phillips Chemical Co., Elter, Texas, is the 15" Permutit Automatic Valveless Gravity Filter, which filters a small side stream and lowers turbidity of the entire system.

New way to shrink yearly maintenance costs—improve heat exchanger operation

Here is a new wrinkle in cooling-tower operation:

Side stream filtration. It can appreciably cut your yearly bill for cleaning fouled heat exchanger surfaces and condenser tubes.

Between the cooling-tower and the heat-exchange operation stands a newcomer to the system—a Permutit® Automatic Valveless Gravity Filter.

Its job is to clean up a small portion of the main cooling water stream, roughly 1% to 5%. By continuously filtering this small side stream the turbidity of all the cooling water is reduced and held to an acceptably low level.

In the system shown here, suspended matter dropped from 2.0 ppm to 0.5 ppm in just one week, and continued to decrease thereafter.

Less turbidity in the cooling water means less fouling of heat exchange equipment. Less fouling, fewer cleanings, more efficient operation.

Costs nothing to operate: To sweeten your savings a little more, the Permutit Valveless Gravity Filter is automatic, in every sense of the word. It operates itself, backwashes itself. Has no moving parts, requires no attendant, no power, no extra pumps. The water used to wash serves as part of the system blow-off—at no extra cost.

Now in use: Proved in this new application, the Permutit Automatic Valveless Gravity Filter is already saving money for several companies.

All you need, to join them, is a little space near your cooling tower, and a Permutit Automatic Valveless Gravity Filter. For more facts, write: Permutit Division, 50 West 44th Street, New York 36, New York.

*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.

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handbook form elsewhere.

Written in simple, easy-to-read engineering language, this book was designed for those who have to select, specify, install and operate boilers of all types. Its 32 chapters cover the full range of subjects, from Classification to Design, to Industry trends.

All of the various types of boilers are described, and the relative merits and applications of each are discussed. This range includes every type from the simple cast-iron domestic boiler, to Marine units, and on to large central-station steam generators.

In addition to the boiler, the book discusses auxiliaries, such as superheaters, economizers and air heaters. Then, to complete the subject, such items as package units and nuclear power are discussed.

This is certainly a long-needed treatise on the practical aspects of boilers; the book should be a must in every power engineer's library.

Guide to U. S. Government Statistics, by John L. Andriot; 3rd revised and enlarged edition; 402 pages, 8¼ by 11 in., cloth binding. Published by Documents Index, Box 453, Arlington 10, Va. Price $15.

This volume covers over 2000 items from the U.S. Government publication program, including the recurring publications, the statistical series, and the many important one-time publications of statistical value.

The volume has two parts: 1. the Guide, arranged by Departments and Agencies, listing the various publications containing statistical data, with appropriate bibliographical information, and annotations of the statistical contents; and 2. the Index, a detailed subject index with each entry coded to show the frequency and type of data.

Industrial Power Distribution Course, produced by The Industrial Electrification Council, 750 Third Ave, New York 17, N.Y. Price for kit approximately $400.

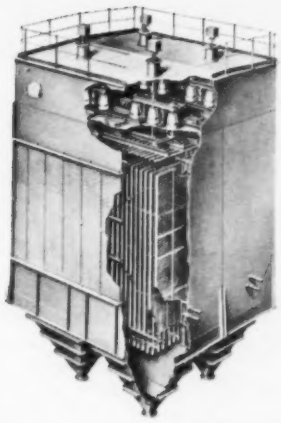
Developed initially by West Penn Power Co for its own use, and field tested, this course has been extremely well received. NECA has been represented in the IEC Industrial Electric Power Distribution Committees and has made many valuable contributions to the course.

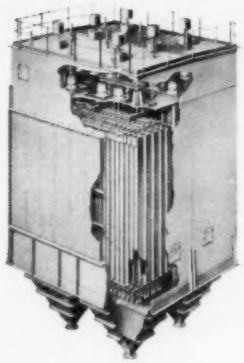
Packaged in the form of a kit, the course consists of the following:

1. Fifty student textbooks.
2. Two leader's guides.
3. 106 slides either for conven-

How Important Is Precipitator Size?

Traditional Design →





Modern Design ←

As shown in these two illustrations, Research-Cottrell's more compact modern design is appreciably smaller than the traditional design.

A common fallacy assumes a larger precipitator with lower gas velocity is preferable to a smaller precipitator with higher gas velocity.

This assumption overlooks important economies now obtained with:

(a) Efficient voltage application.

(b) Specific control of electrical sections.

(c) Electrode design improvements.

(d) Automatic Rapper Control.

(e) Accurate internal baffling.

(f) Proper control of gas flow, based on three-dimensional model studies.

Close familiarity with these techniques and improvements has made possible guarantees of 99 per cent collection on large, modern installations.

A. Applied Voltage

The relationship between voltage and size of the precipitator is approximately as shown in Figure 1.

Most efficient operation and minimum size are obtainable by insuring operation at maximum voltage under varying conditions of gas flow, particle size, resistivity, etc. Generally, the amount of arc-over in the precipitator will determine the practical operating voltage limit. By using the arc-over as the motivating control factor, through measurement and integration, maximum voltage can be insured at all times.

B. Sectional Voltage Control

Since gas conditions vary throughout any precipitator, higher efficiencies are obtainable if the precipitator is sectionalized with individual voltage control for each section.

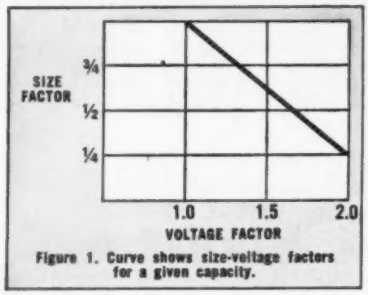


Figure 1. Curve shows size-voltage factors for a given capacity.

C. Electrode Design

Efficiency can be seriously affected by re-entrainment (that is the re-suspension of dust that has already been collected). Properly designed collecting electrodes, or plates, providing correct baffling to shield the collecting surface against the sweeping and scouring effects of the gas stream can reduce over-all precipitator size 25–50 per cent.

D. Automatic Rapper Control

Rapping intensity must vary to meet the changing conditions of gas flow, particle size and resistivity. Otherwise, efficiency will decrease due to either too heavy a blow causing a re-entrainment, or too light a blow allowing dust build up on the electrodes necessitating operation at reduced voltages. Automatically controlled, fully adjustable rapping equipment insures optimum operation at all times.

For more data circle 534 on Post Card

E. Internal Baffling

Maximum efficiency can only be obtained by reducing the sneakage (part of gas stream which leaks or sneaks around the treatment zone) to an absolute minimum through the proper design and use of internal baffling proven by model studies and research on full size precipitators.

F. Gas Flow—Model Studies

Proper gas flow patterns across the face of the precipitator can result in a 25–50 per cent reduction in over-all size. The use of transparent plastic three-dimensional model studies as well as field research has resulted in refinements in design never before possible.

Only at Research-Cottrell can you be assured of these latest of design techniques and improvements providing the most economical selection of equipment and efficiency of operation. Research-Cottrell personnel, backed by nearly a half century of gas cleaning experience, stand ready at any time to provide information or service.

For details or more information relative to the data contained herein, or any other general inquiries, please contact your nearest Research-Cottrell representative or write directly to:

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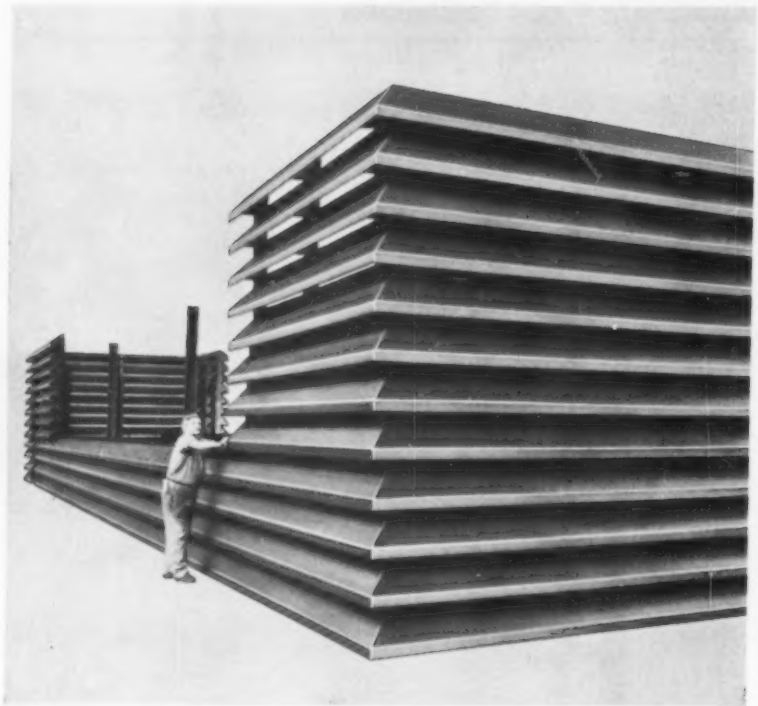

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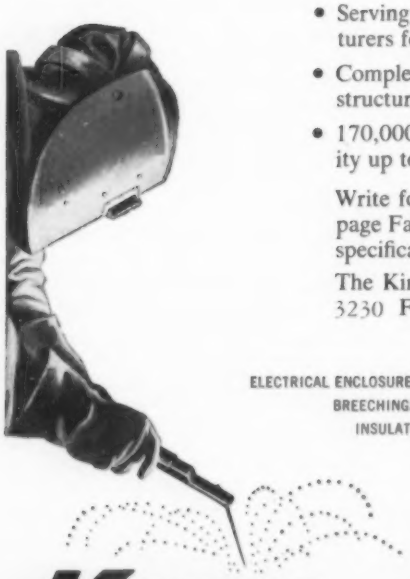

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Designed for presentation in ten 2½-hour demonstration type lectures, the course will give complete coverage to the many electrical distribution problems encountered in the smaller and medium-sized industrial plants.

Purpose of the course is twofold: 1. To familiarize industrial power sales engineers, equipment salesmen, jobbers, distributor salesmen, and contractors with industrial electric power distribution systems; and 2. to educate industrial plant personnel in the selection of electrical systems and components, and to better appreciate the latest equipment methods and techniques as well as the many advantages of good electrical distribution.

Handbook of Noise Measurement, by Arnold P. G. Peterson and Ervin E. Gross, Jr; 132 pages, 7 by 10 in., paper cover. Published by General Radio Co, West Concord, Mass. Price $1.

This extensively revised fourth edition offers a comprehensive survey of such topics as the decibel, man as a noise-measuring instrument, applications of sound-measurement systems, and the measurement of sound levels and sound pressure levels.

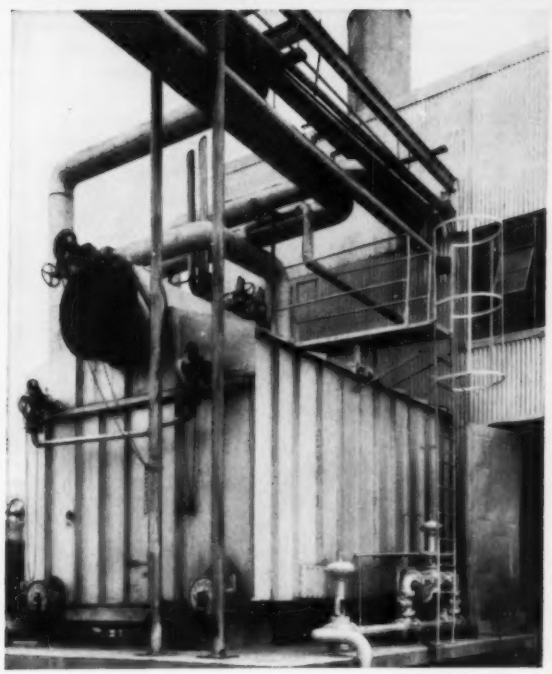
Also detailed are the characteristics of noise control, loudness levels, speech interference, hearing damage, and neighborhood reaction to noise.

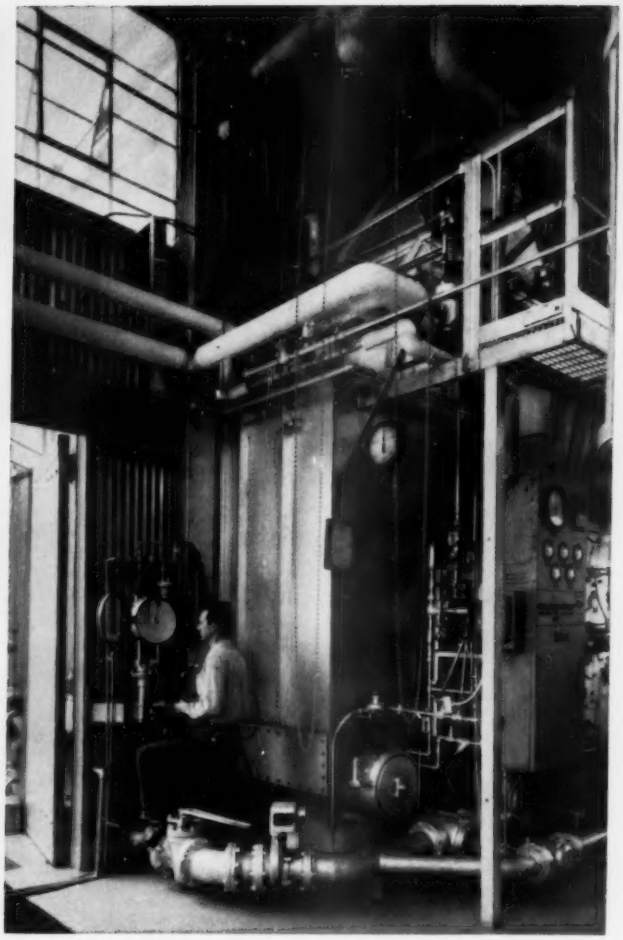
Typical noise sources are discussed, and vibration measurements are the subject of reports on typical instrumentation and applications. The book is well illustrated and includes four appendices with decibel conversion tables, vibration charts, definitions and extensive references.

Modern Mathematics for the Engineer, edited by Edwin F. Beckenbach; 456 pages, 6 by 9¼ in. Published by McGraw-Hill Book Co, Inc, 330 W. 42nd St, New York 36, N.Y. Price $9.50.

This book is the result of the 1958-1959 series of lectures by experts on advanced applied mathematics, conducted by the University of California through University

Processing wallboard at Kaiser Gypsum





Union Packaged Boiler takes increased load in stride

A good part of the steam for processing gypsum wallboard at Kaiser Gypsum Company's Long Beach plant is supplied by the Union Type MH Packaged Boiler shown.

Semi-automatic fired with a normal operating pressure of 200 psi, this compact unit went on the job in 1956. Installed outdoors, it eliminated the need for further extension of the existing boiler house.

Although originally furnished to deliver steam for 2 out of 5 zones in a Coe Dryer, the MH was later hooked up to carry more of the load handled by an older boiler. Says the engineer-constructor, Kaiser Engineers: "The extra load demand on the Union Boiler was hardly noticeable from an operating standpoint."

Throughout industry, similar reports verify reliable Union performance on stiff assignments. Job-proved designs, complete shop assembly, compactness, easy installation and above average efficiency combine to make Union MH Steam Generators the best dollar-for-dollar buy on the market.

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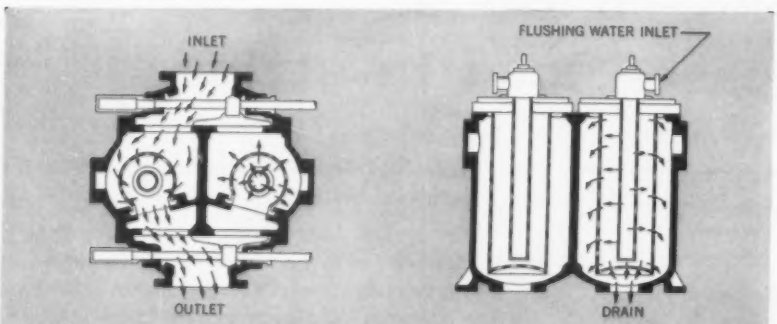
● This Elliott type A Twin Strainer is built to handle 2000 gpm of river water ● provides continuous flow of clean water for New Jersey industrial plant ● geared electric motors shift the valve discs and operate the rotary spray pipes ● this design is capable of handling extremely bad water ● one basket is automatically cleaned while water flows through the other basket, assuring continuous service.



Geared electric motor shifts the valves, sealing off one basket for back-flushing, while uninterrupted water flow passes through the other basket.

Geared electric motors revolve spray pipe sending jets of flushing water against inside of basket, removing accumulated debris, which is flushed out the drain.

AO-2

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Extension. The material is intended to be quite understandable in the large, although not necessarily in complete detail, on the basis of the single lectures.

In Part I, sophisticated mathematical methods are developed. Part II is devoted to the rapidly expanding probabilistic and statistical methods that are having such a strong impact on today's physical, biological, economic and sociological technology. Part III establishes procedures for determining solutions for a wide range of complex problems by application of Monte Carlo methods, matrix methods, and machine computation in most imaginative ways.

The book is intended for engineers, scientists, mathematicians, students, teachers, and others who wish to keep abreast with current applied mathematical developments.

1961 Verified Directory of Manufacturers' Representatives, 217 pages, 8½ by 11 in., spiral bound. Published by Manufacturers' Agent Publishing Co, 554 Fifth Ave, New York 36, N. Y. Price $20.

Third edition, and first revision in two years, this directory lists more than 15,000 manufacturers' domestic and export representatives in the U.S., Canada and Puerto Rico. Listings are arranged geographically and include the principal products each "rep" carries and the trading area covered. In addition, the publication indicates prevailing commission scales for various products, and includes suggested manufacturer-manufacturers' representative contract forms.

Introduction to the Statistical Dynamics of Automatic Control Systems, by V. V. Solodovnikov, translation edited by John B. Thomas and Lofti A. Zadeh; 307 pages, 5¼ by 8 in., paper cover. Published by Dover Publications, 180 Varick St, New York 14, N. Y. Price $2.25.

The author, a leading Soviet engineer, develops in this work the general theory of control systems subjected to probabilistic or random signals. He brings together the results of a great deal of research in this field that has heretofore existed in scattered American and Russian journals. The work constitutes one of the first comprehensive treatments of the subject, and presents an explanation of the principles of the analysis of linear systems, the statistics of random signals, and the theory of linear prediction and filtering.

ANOTHER
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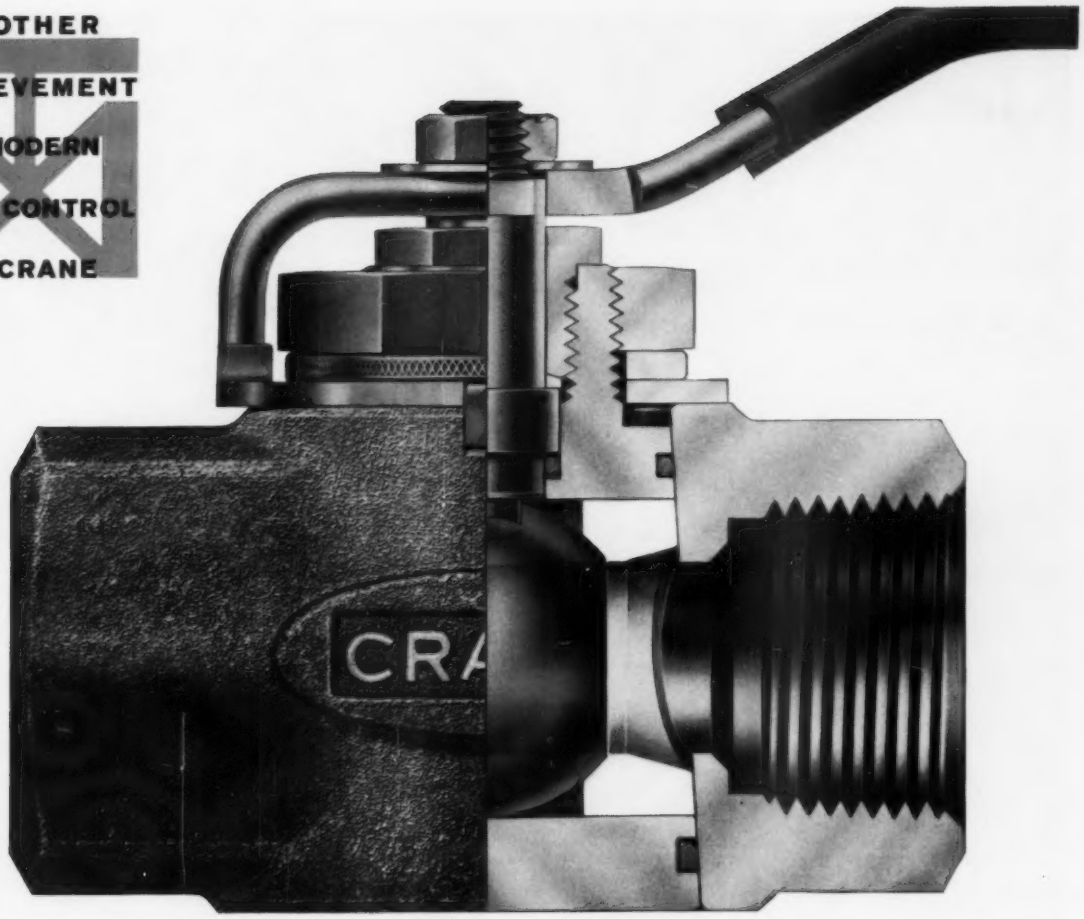
IN MODERN
FLOW CONTROL
BY CRANE



this ball beats all!

CRANE BALL VALVES are engineered for superior flow control and minimum-maintenance operation. The secret of this valve's all-around outstanding performance is its beautifully simple, Crane-designed tapered cartridge containing all the working parts. While the valve body remains in line, acting as a pipe connection, the entire cartridge may be removed from the bottom, quickly and easily, for fast exchange or simple, low-cost maintenance.

Precision pre-loaded Teflon* seats assure bottle-tight closing in either direction with a quick, easy quarter turn of the bright, Crane orange insulated handle. The self-aligning, precision machined ball is polished and chrome-plated to reduce friction and wear on the self-cleaning seats. All steel parts are plated for corrosion resistance. Crane Ball Valves handle fluid, gas and air services from vacuum to 800 psi and temperatures from –40 to 400F. Available now from your Crane Distributor for prompt delivery—sizes from ¼" to 2", screwed ends, in bronze, carbon steel, and Type 316 Stainless.

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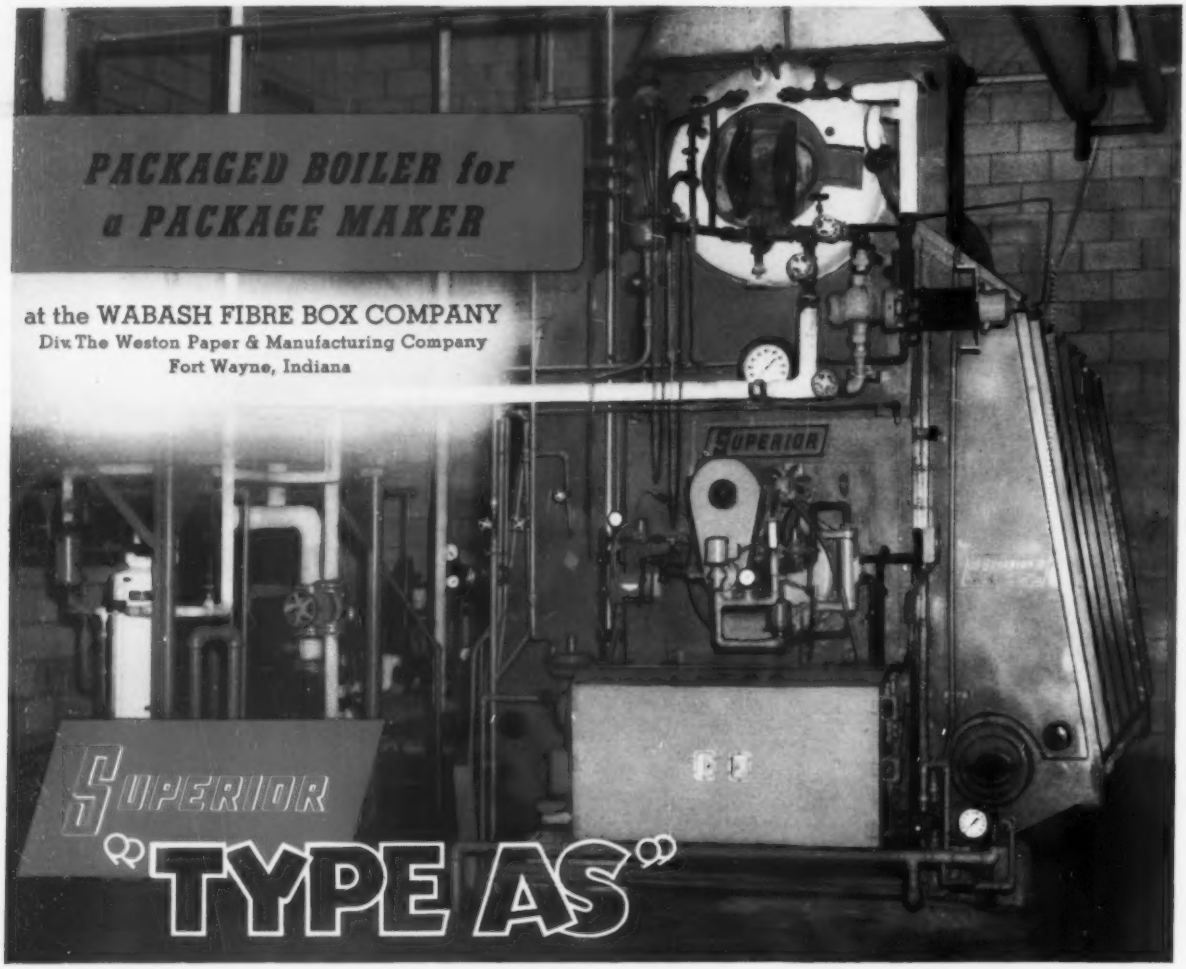
PACKAGED BOILER for a PACKAGE MAKER
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Note in this Type AS installation, the uncluttered firing front . . . result of rear-mounted draft fan and soot blowers. Note controls at floor level, affording accessibility without need for ladders or platforms.

The boiler's baffleless design (unusual in boilers of this capacity) results in complete freedom from dangerous gas pockets. With its Superior Rotary Burner, maximum safety and efficiency for fully automatic operation are assured.

To be used for both heat and process, providing 13,000 lbs of steam per hour at 190 psig, Superior's Type AS Completely Packaged Boiler was selected as the ideal "package" for this package maker.

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Current Catalogs

continued from page 28

elevator systems for bulk handling of coal, chips, chemicals, gravel etc. Illustrates basic bucket-elevator types. Gives factors to be considered in selecting elevator for a given handling problem, includes practical examples of selection. Tabulates 101 bulk materials regularly handled and 318 possible elevator types.

148 Car Shakeout—New trackside shakeout of Hewitt-Robins is described in Bulletin 172. Text tells how it provides simple, automatic push-button operation even from remote control stations, offers economical installation and maintenance. Photos show how it works.

Boilers and Auxiliaries

149 Packaged Steam Generator — Features and operational advantages of Foster Wheeler Co.'s packaged steam generators designed for maximum economy are detailed in Bulletin PG-61-1. Capacity and dimensional information included.

150 Soot Blower—Described in 8-pp Bulletin 1063 by Blaw-Knox Co. is a long retractable soot blower with electric drive. Photos and line drawings illustrate design features, also show effective cleaning accomplished by infinite number of double-helix paths made possible by the use of the dual motor drive.

Other Equipment

151 Industrial Silencers—Bulletin STM describes Silentflow tubular mufflers of Silence Inc. designed for silencing gas discharges and intakes. Models for maximum, medium and minimum noise reduction are presented. Acoustic and airflow performance data provided.

152 Centrifugal Pumps—Information on high pressure multi-stage centrifugal pumps of Goulds Pumps, Inc. is contained in Bulletin 722.4, 8 pp. Models described have capacities to 2600 gpm for heads to 3400 ft. and working pressure to 1200 psi. Specifications, performance curves, materials, dimensions are given.

153 Tube-Type Lubricant — How measured lubrication in handy tubes helps avoid bearing failure in electric motors and generators is explained by Fairbanks, Morse & Co. in Bulletin 2101. Tables list recommended amounts of pre-measured lube-in-tube for various types of motors and generators.

154 Rotary Positive Blowers—How a lobe-type, rotary positive displacement blower delivers a metered amount of air against varying pressures with a minimum amount of friction is explained in 12-pp Bulletin S-32-A by Sutorbilt Corp. Diagrams and charts illustrate blower design, and dimension and performance data.

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155 Shell and Tube Exchangers — Pre-engineered shell and tube heat exchangers using standardized components, for use in petroleum, petrochemical and chemical industries, are featured in 24-pp Bulletin 101 by The Griscom-Russell Co. Includes engineering data including design and construction details, setting plans, stacking dimensions, tube counts.

156 Pneumatic Products — Catalog 1000, 64 pp, covers pneumatic products available from C. A. Norgren Co. Describes compressed-air-line filters, pressure regulators, air-line lubricators, valves, others. Also provides practical engineering information, such as compressed-air flow chart, moisture content of saturated, compressed air, dimensional data.

157 Fuel Oil Additive—Advantages of Sludgenemy Plus Catalyst a liquid additive for fuel oil, are described in Bulletin 461 by Universal Refining Products Co., Inc. Explains how product disperses sludge, reduces excessive soot formation and prevents system corrosion.

158 How Silicones Are Used — Eight-pp Bulletin CDS-129C contains descriptive details on General Electric Co.'s silicones and their uses. Catalog is broken down into four general categories dealing with silicone fluids, silicone protective coatings, silicone electrical insulation and silicone rubber.

159 Coating and Compounds— Characteristics and applications of a synthetic rubber compound for all types of sealing and caulking jobs, and a line of protective coatings for industry are described by David E. Long Corp. in DEL Bulletin 105. Performance data and suggestions for applying are given, along with a chemical resitance chart.

160 Thermal Dryer — The Flowdryer, for thermally drying coal and other minerals, is described in Bulletin 361 by The McNally Pittsburg Mfg. Co. Illustrated by cutaway, and dimensional drawings, text covers construction and operation of the dryer, also discusses automatic control.

161 Venturi Accessories — Bulletin 110.20-2, of B-I-F Industries, gives description and diagrams on straightening vanes, vent cleaners, flushing devices and special chambers. Drawings detail proper installation and application.

162 Precisioneered Coal—This 16-pp brochure highlights coal mining, preparation, research and service facilities of Island Creek Coal Co. and includes flow chart of a preparation plant. Also describes 11 brands of coal as to performance and application characteristics.

163 Hinged Closures—Quick-opening hinged closures for blanking off pipeline ends and tank or vessel openings are described by Tube Turns, Div., Chemetron Corp., in 6-pp Bulletin TT-1034. Illustrations of typical installations and charts giving dimensional specifications included.

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Equipment News

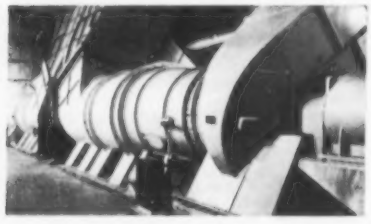
Reader Service Cards on pages 91-92 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

1—Coating protects chimneys against acid corrosion

Stackfas is a spray-applied, non-asphaltic coating for the interior of brick, steel and concrete chimneys. Formulated to resist acid corrosion from high sulfur fuels, this product is claimed effective against acids formed by sulfur dioxide, sulfur trioxide, hydrogen chloride and hydrogen fluoride. According to Benjamin Foster Co., Stackfas was developed to resist destructive corrosion resulting from greater use of more economical low cost coal, heavy fuel oil, refinery sludge and sour gases in boiler operation. Tests of Stackfas in public utilities and chemical plants are reported to show outstanding resistance to acids, heat and fly ash abrasion.

2—Variable axial flow fan for induced and forced draft

Danish designed Variax Fans, offering variable rpm from 0 to maximum output, are introduced in this country by Novenco Inc. The compact standard Variax is reported to attain higher-than-average rotational speeds



with safety. Versatility is provided through interchangeability of snap-out blades with a variety of fin structures. Horizontal and vertical models are available for installation in tight spots and short overall length reduces space requirements. Fans are controlled during operation by variation of blade angle. They come in standard sizes for capacities from about 50,000 to 1,100,000 cfm; larger sizes produce pressures to 25 w.g. Standard fans operate at temperature to 400 F; special units at higher temperatures.

3—Protection package—breaker in individual enclosure

I-T-E Circuit Breaker Co. announces that the K-Don line of circuit breakers—low-voltage current-limiting units affording fault protection against currents up to 200,000 amp—is now avail-

able in individual enclosures for application where single, wall-mounted breakers are used. The enclosures afford large and accessible cable make-up area; ease of trip unit adjustment and maintenance; drawout operation; visible break disconnect contacts. Individually enclosed breakers can be had for electrical or manual stored-energy operation in 600- and 1600-amp ratings, up to 600 v a-c or 250 v d-c. Bulletin 4300-1A gives details.

4—Sulfamic acid cleaners for use on scaled equipment

Two sulfamic acid base cleaners announced by E. F. Drew & Co., Inc. are Improved Saf-Acid and Saf-Acid G. The former is a fast-acting, powdered scale remover inhibited to prevent corrosion and foaming. Saf-Acid G is a specialized acid cleaner, reported safe for use in systems containing galvanized metal.

5—Stud tensioner speeds pressure vessel head closure

The Diamond Stud Tensioner of Diamond Power Specialty Corp. is designed to reduce—by up to 75 per cent—the head closure time for nuclear reactor and other pressure vessels. It is essentially a power hydraulic jack which can engage 2- to 8-in. stud bolts and apply a straight tensile load to literally stretch the bolt within its elastic limits. This action applies a like load to compress the heat closure flanges. With stud and flanges under load tensioner, the head closure nut is manually run down to maintain full loading when the tensioner is disengaged. Tensioners are designed for capacities from 20 to 1000 tons. Since head bolting time is directly proportional to number of tensioners, two or more are recommended to minimize outage time and promote even seating of closure.

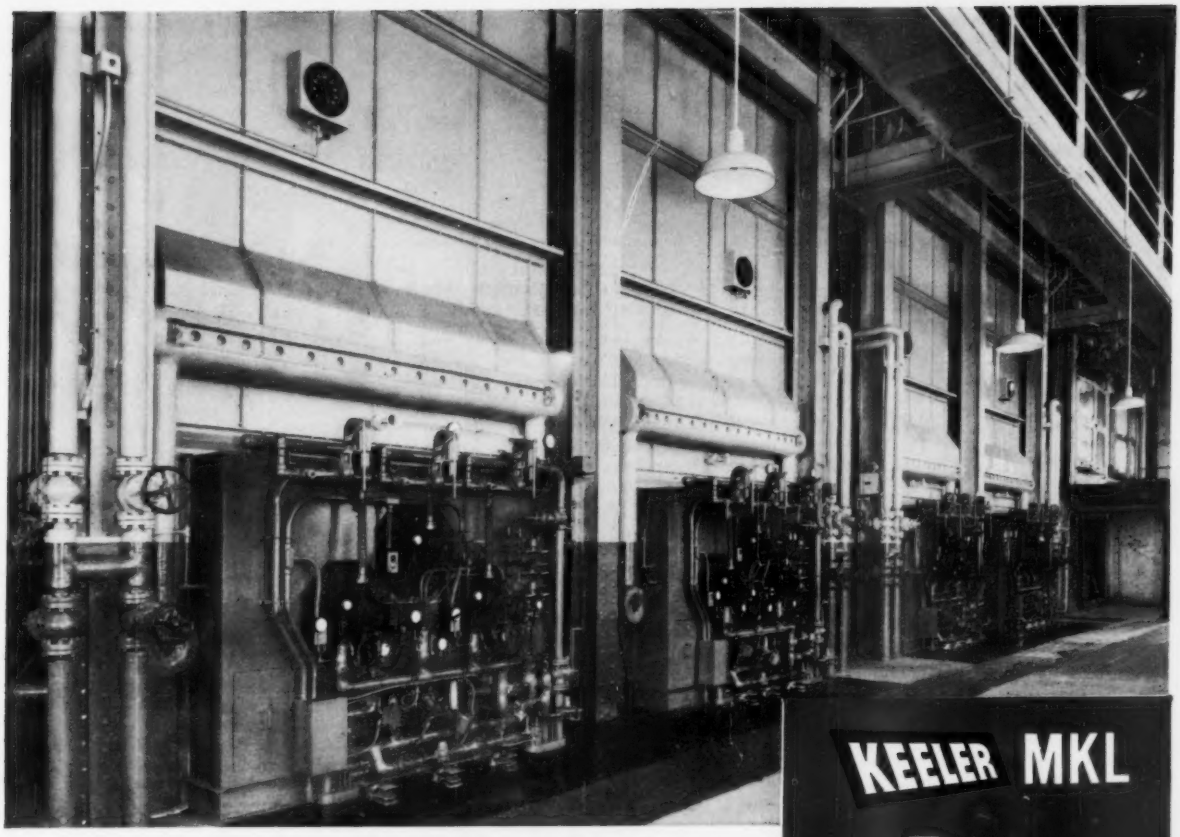
Several advantages are stressed by manufacturer: The hydraulic jack principle eliminates need for heating studs. Bolt elongation can be closely controlled. Thermal overstress is eliminated. Absence of torque in producing bolt loading eliminates requirement of load capacity correction for combined torque with tensile loading. High pressure hoses are not required.

6—Dust level alarm uses no moving parts in hopper

This device of Aerotec Industries, Inc. consists of a differential pressure switch unit and two sensing cones for installation at different levels in the hopper. Whenever fly-ash or other finely divided dry material reaches a pre-determined level (indicated by the lower cone) a pressure differential triggers the switch, which in turn electrically actuates an external alarm. Actuating unit, installed outside the hopper, contains the only moving parts: a Micro-Switch and a differential pressure diaphragm. It also accommodates pressure sensing line for each side of diaphragm, one line extending to high pressure end bell and the other to the low.

7—Big tractor loader for coal handling, other stockpiling jobs

Model TL-30, a four-wheel drive unit is the newest and largest of the tractor loaders of Allis-Chalmers Mfg. Co. It has a 10,500-lb carrying capacity, maximum lifting capacity of 25,000 lb, is powered by a turbocharged diesel engine rated 184 hp at 2200 rpm. A single lever permits power shifting on the go at any speed, forward or reverse. A single lever lets the operator move into a stockpile and instantly drop into low crowding speed for full-capacity loading and reverse direction instantly. Six buckets available for the TL-30 range from 2½ to 6 cu yd. Bucket and linkage design give the unit a breakout force up to 28,000 lb and a 42-deg tip-back at ground level. The unit also has a



Consulting Engineers: H. M. WILSON CO., INC., Philadelphia 30, Penna.

FOUR KEELER TYPE MKL STEAM GENERATORS EXCEED EFFICIENCY GUARANTEE AT SEARS

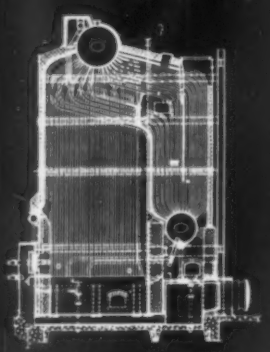
The Sears, Roebuck and Co. mail order plant in Philadelphia encompasses millions of square feet of usable space. The entire steam requirement plus adequate standby is supplied by four quick-response Keeler Type MKL Steam Generators installed in a recent modernization.

Test results have exceeded the guarantee of efficiency and their operation has been *"most satisfactory"!* The new MKL's are 40,000 lb stm/hr combination oil-gas, custom-designed units, 175 psi operating pressure. They were installed in the space previously occupied by four of the six 500-hp boilers which they replaced.

The space and versatility advantages experienced at Sears are typical of Keeler MKL's. The basic design provides true economy and efficiency with quick response to load changes. MKL's are cross drum, bottom supported type available in capacities up to 70,000 lb stm/hr. They're easy to maintain, flexible to space requirements, efficient and durable.

There's a dependable Keeler Water Tube Steam Generator for every requirement . . . from low cost package units to 100,000 lb/hr and field erected units up to 200,000 lb/hr—for all fuels, all types of firing. *Write or phone for complete information . . .*

KEELER MKL



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KEELER WATER TUBE Boilers

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ROEBUCK AND CO.
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Philadelphia

The plant serves catalog customers in 8 states and the District of Columbia. Also located here are Sears' eastern territory headquarters offices, a department store, rail and motor freight terminals and warehouses.

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maximum dumping clearance of 10 ft, 4½ in. and a 37½-in. reach forward from the tires for center loading of high, wide truck bodies.

8—Closed circuit monitors for industrial television

An expanded brightness range fits these monitors for use in areas of high ambient light, and because of this, General Electric Co. has made available an accessory polarized safety glass faceplate for further minimizing reflections and improving contrast ratio. Monitors are suited to surveillance of hazardous areas, gate monitoring,

meter reading, security surveillance, pipeline inspection, technical instruction etc. Although capable of three times the picture quality of home sets, they are simpler to maintain and adjust.

Monitors come in cabinets or rack mounting and in three screen sizes: 14, 17 and 21 in. Size, focus and linearity controls are operated individually—adjustment of one doesn't affect the others. Input circuit is said to substantially cancel out picture disturbance caused by surrounding high-current wires. Monitors operate with any standard monochrome camera.

9—High-pressure shut-off valve with improved Teflon seat

Clayton Mark & Co. announces a high pressure shut-off valve with Teflon seat which is compressed into a positive sealing O-ring. Housed in a stainless steel swivel cage attached to a

free-turning Monel stem, a portion of the seat is forced from cage as valve stem is screwed down to closed position, forming a Teflon-to-metal seal. Valve is suitable for a wide range of applications and impervious to most fluids. It comes in four sizes from ¼ through ¾ in.

10—Packaged pumps are close-coupled end-suction units

Reduced space requirements and faster, easier installation are claimed for these pumps by Aurora Pump Div., The New York Air Brake Co. Disassembly without disturbing suction or discharge piping facilitates inspection and maintenance. Vertical centerline discharge makes pumps self-venting, eliminating possibility of vapor lock and providing smooth operation with low noise level. Pumps come in sizes from ¾ by 1 to 3-by-3 in. Capacities range to 400 gpm, heads to 150 ft.

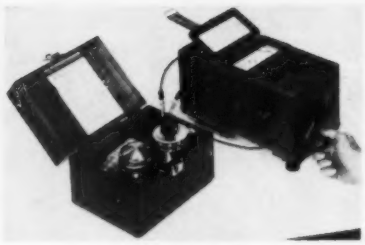
11—Outdoor cutouts incorporate built-in load break

The LBU line of distribution cutouts, available from Westinghouse Electric Co., features a built-in load break designed to operate for the life of the cutout without maintenance. It is reported safe for linemen to operate with a hookstick. Load current is normally carried through main contacts (and fuse link). In parallel with these are a quick-break blade and another pair of contacts located with an arc chute. As the hook eye is pulled, main contacts unlatch after closing the other quick break contacts. With current now through the blade, the operator continues to open the cutout, cocking the blade against a coil spring. When main contacts are open to where they cannot restrike, the blade snaps open, drawing an arc through the deionizing chute.

The LBU comes in 15-kv ratings, continuous current, 100 amp with up to 20,000 rms amp fault interrupting rating. It can also be had with 200-amp solid-blade disconnect and 200-amp load break ability. The same new cutout is available without the load break (LDX), 7.8 or 15 kv, heavy or extra heavy duty.

12—Multi-layer sectional pipe insulation withstands 1200 F

Zebra, a multi-layer type pipe insulation, useable up to 1200 F, is available from Keasbey & Mattison Co. This sectional insulation is composed of bonded felts of calcium silicate and asbestos fiber. Sections can be cut and fabricated on the job — sawing creates no dust and the materials are non-irritating to the skin. The multi-layer construction provides toughness, vibration- and crush-resistance.

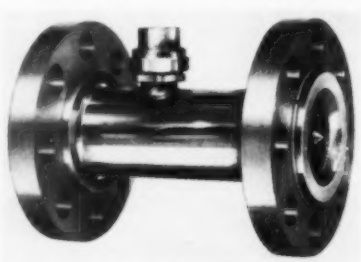


13—Test cell kit for measuring resistivity of liquids

Offered by James G. Biddle Co. for use with a Megger insulation tester in measuring resistivity of such liquids as transil oil and insulating varnishes, the Biddle-Balsbaugh Cell is packaged as a kit with a jar for storing the cell while not in use. The jar holds appropriate solvents and a spring fixture for securing the cell when it is immersed in the solvent between tests. An aluminum beaker and polyethylene-coated paper cups are provided. Three test leads supplied have insulation for test voltages up to 5000 v d-c. For maximum cell protection, the kit is contained in a sturdy case with carrying handle.

14—Turbine flowmeters have removable assembly feature

These turbine flowmeters for totalizing, recording, blending, telemetering and measurement applications are available from Cox Instruments Div., George L. Nankervis Co. in 12 sizes for flows from 5 to 12,000 gpm with



linearity of 0.05 per cent of flow. Electrical pickup terminates in a conduit fitting for installation in hazardous and exposed areas. Meters operate at pressures to 3000 psi and temperatures from —455 to 500 F, with pressure drop of approximately 4 lb. Turbine assembly is removable for cleaning and inspection. Bulletin 1384B-2 gives details.

15—Alarm scanner scans 200 points at high speed

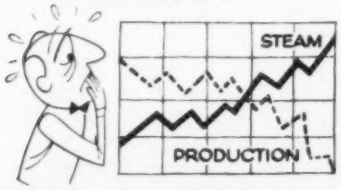
This transistorized alarm scanner is capable of scanning up to 200 measured variables at the rate of one point per second, according to The Bristol Co. On discovery of any "off-normal" situation, the instrument activates a recorder (which records the alarm condition measurement and reports its

ONE OF A SERIES OF CHATS ABOUT THE CONSERVATION AND CONTROL OF HEAT

SARCO TOPICS

STEAM CONSUMPTION WAS ERRATIC AT THE SHERATON-ATLANTIC

This is a documented steam story, and if you have the *least* interest in reduction of steam costs you'll read on. The events took place in the laundry and dry cleaning department of the Sheraton-Atlantic Hotel in New York, which purchases district steam; but they could have happened in *any* steam using establishment — including your plant.



This documentary is concerned with money — (their steam bills for laundry and dry-cleaning were tremendous) and how the Sheraton cut the bill $8500 in one year. That's giving away the climax, but not the plot. To begin with, the Sheraton engineering department kept a daily log which revealed excessive steam costs and startling discrepancies. For example, on one day, 44,000 lbs. of district steam were metered and 20,300 pieces finished. On another day, 38,000 lbs. of steam were metered and 23,300 pieces finished. Clue: This ratio was obviously cockeyed!

To relieve your suspense, we can tell you that the Sheraton removed competitive bucket traps and installed around fifty Sarco Thermo-Dynamic Steam Traps, Type TD-50, on the discharge side of each piece of steam heated equipment, and on drips on supply mains between meters and equipment, as recommended by Sarco. The results were dramatic. (Strong men didn't weep, but they did clap their hands a bit.) In the pre-Sarco December, 868,000 lbs. of steam were purchased for $1725. In the post-Sarco December, only 532,000 lbs. of steam were purchased, for $1025. And the volume of work had increased!

There are no crystal gazers on the Sarco staff; lots of competent engineers, though. These steam detectives find inefficient steam trapping at the bottom of countless high cost mysteries. Sad part of it is, the high cost of steam is only part of the story. Inefficiency in trapping can create other costly problems, too.

We talk a lot about our Thermo-Dynamic trap, don't we? So do other people. In fact we're quite used to grateful cheers of appreciation. Why don't you get the full story, by asking for it? Phone, telegraph, mail—choose your favorite medium of communication.

SARCOTROL! OUR WORD FOR SOMETHING SPECIAL IN TEMPERATURE CONTROL

It may be just what you've been looking for. We don't know. It's rather unusual. We know what it can *do*, but we still don't know everyone who needs it, even though we've been selling Sarcotrol successfully for many years to the plastic fabricating industry. New people we never heard of keep popping up saying it's just what they've needed.

When we designed Sarcotrol we planned it for specific use as a heating and cooling unit for injection molds, cylinders, rolls and drums. What surprises us is that so many different kinds of other equipment are evidently now in search of just such a control, from Banbury mixers to electric coffee pot testers.

The Sarcotrol is a portable, automatic temperature control system utilizing closed recirculation of the heat transfer fluid, to insure even temperatures throughout the equipment being heated and/or cooled. Here's the operating principle. Btu's are supplied to or removed from the rapidly moving high-pressure, high temperature fluid; the variations between delivery and return temperatures being held to a very narrow segment of the Sarcotrol's wide temperature adjustment range. A broad range of flow rates is available to handle widely varying heating and cooling loads, while maintaining tight control of temperatures across the equipment. The basic control mechanism is our own electric indicating controller. Four

standard, fully adjustable, working temperature ranges, cover all heating or cooling requirements between 0° and 300°F. (Keep reading . . . you can always go back for details.) On start-up, full heater capacity is available, and when circulating water approaches control point, heat input is automatically reduced for closer control. Temperature control instruments are automatically compensated for ambient temperature variations.

Heard enough? If not, you must feel a responsive chord vibrating, so write for details. There's literature available which contains much more information than we can give you in this chat.

OUR NEW PUBLICATION IS PRACTICAL—PLUS

SARCOSCOPE is our new house magazine into which we pour what we hope will be a useful mixture of ideas, case histories, tips, facts, news, and sense — both common and uncommon. If you are not receiving

it, we'll be happy to send future issues to you. Just send your name and address. Sarco publishes it as a service to people interested in the conservation and control of heat. We try to keep it down-to-earth, practical and useful.

SO YOU THINK YOUR PROBLEM'S UNIQUE?

Lots of hot water and steam is being wasted these days, in lots of ways. If your eyes glaze as you watch your steam bills mount or shut down your equipment for maintenance, you probably wonder what you did to deserve such problems. If it's any consolation, it's very unlikely that you are alone in your misery. The chances are excellent we have solved just such a problem already for plants similar to yours. Try us. Describe your problem in a letter. We'll probably be able to send you a set of Sarco Case Histories, describing how other plants were able to conquer problems like yours.

5897

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STEAM TRAPS • TEMPERATURE CONTROLLERS
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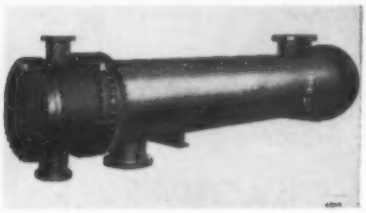
exact location), actuates a red alarm lamp, and energizes any desired external alarm system. Upon completion of these functions, it returns to normal scanning—leaving alarm lamp "on" until a reset button is depressed.

16—Heat exchangers with removable bundles, full floating

Heat exchangers in the C-500 Series of American-Standard Industrial Div. are suggested for applications where frequent tube cleaning is necessary and/or thermal differential expansion between shell and tubes becomes a problem. They are built from stand-

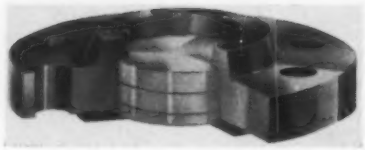


ard components assembled into custom units to save time and user cost. With floating head clamp-ring design, these exchangers will handle any combination of liquids and gases, including those which are toxic, volatile or flammable. They may be used as heaters, coolers, condensers or vaporizers. They come in 19 shell sizes from 6 through 42 in., with any practical tube length in two-, four- and six-pass arrangements. Shellside and tubeside design pressures 75 to 300 psi.

17—Insulating silicone-base grease now comes in spray form

Insulgrease, designed to alleviate effects of atmospheric contamination deposits on insulators and previously applied with brushes and rags, has been developed for use as a spray by

General Electric Co. The silicone-base coating can be sprayed directly to insulators at any thickness simply by clamping special spray equipment to the containers. Besides saving time and labor, this method also avoids fogging and overspray. In an initial large-scale application, more than 10,000 lb was sprayed, without necessity of adding liquid carriers, on insulators at a 48-acre switchyard containing equipment rated at 115, 230 and 345 kv.



18 — Safety sight glass has simplified mounting design

Produced by Cyclops Industries for high pressure and temperature applications, these safety sight glasses consist of two basic components: the laminated lens, bonded in lens holder as one integral unit, and the flanged mounting body. Lens packing, adjustment screws, and adjustment rings have been eliminated. Lens has two tempered, glass pressure disks, each with a multiple safety factor. Each disk can withstand full rated flange pressure so that if one disk breaks, the other stays in operation. A third disk acts as a shielding disk to protect pressure disks from chemicals.

19—Fuel oil additive boosts furnace efficiency, lowers smoke

Solar Chemical Co's Furnace Kleen comes in two formulas: F.O.A. is for Nos. 2 to 5 fuel oil, and B.O.A. is for No. 6 or Bunker C oil. You add it on top of the fuel oil—a gallon to 1000 gal of the oil. A Pinsky-Martin closed-cup rating in excess of 148 F makes Furnace Kleen less hazardous than standard additives with ratings of 70 F, manufacturer points out. The additive is designed to prevent fuel tank corrosion, dissolve and disperse sludge, emulsify moisture in fuel tank.

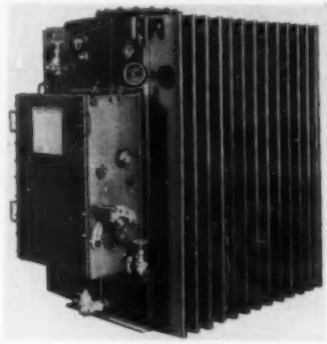
20 — Cam-action couplings speed equipment disassembly

Closures requiring as many as 24 nuts and bolts can be replaced by cams with the C-L Couplings made by Camlock Flange Sales Corp. Anywhere from two to five cams are used on each flange, each cam replacing from four to six bolts. The two flanges are locked in place by a partial turn of each cam with a rod, which is

supplied. Each coupling is rated at 150 lb ASA. Couplings are available for openings of from 2 to 16 in. diam.

21—Network transformers offer space-saving advantages

Compact network transformers, designed to fit into close quarters, are offered in 300 through 2500 kva ratings by Wagner Electric Corp. Space-saving features permit uprating existing secondary network systems by



installing higher transformer ratings in present vaults, and lowering construction costs on new systems. Enclosures have corrugated walls for easier cleaning and maintenance. Beveled corner joints reduce across-the-grain flux. Transformers are available with standard high voltages of 2400/4160Y through 34,500 v, and low voltages of 216Y/125 and 480Y/277 v.

22—Wire stripper works like a pair of pliers

One squeeze of the handles on this tool strips insulation from both stranded and solid wire. An arm automatically drops down to hold jaws open and prevent crushing of stranded wire. After wire is removed,

a second squeeze releases arm and stripper is ready for the next wire. Alignment of stripping holes to prevent cutting or scoring of wire is assured by "V" notches on stripping blades. A product of Holub Industries, Inc., stripper comes in three sizes: Model AS-02 for No. 22-10 wire, Model AS-2 for 18-10 wire, and Model AS-3; No. 14-8. Priced around $6.

23—Transistorized recorder for magnetic flowmetering

This rugged and compact recorder features transistorized circuitry, positive drive action, built-in voltmeter and direct reading range dial. According to Fischer & Porter Co., it pro-

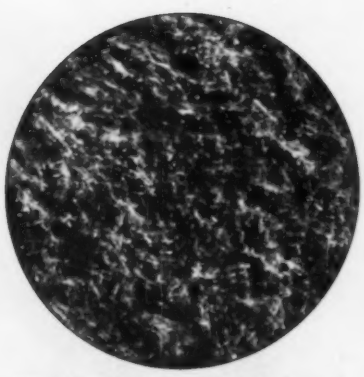
IT'S THE INTERLOCK THAT MAKES MONO-BLOCK®

It's no wonder that hundreds of industries' leaders specify Baldwin-Ehret-Hill Mono-Block for their medium and high temperature block insulation requirements, up to 1800 F.

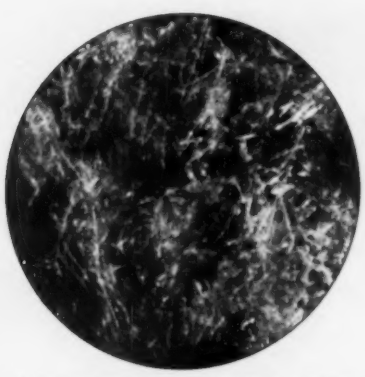
The reason? An exclusive Baldwin-Ehret-Hill manufacturing process assures that the fine mineral wool fibers used in Mono-Block are completely and thoroughly dispersed in a liquid slurry and thereby interlocked to provide the highest strength. Further, this interlocking process means that Mono-Block will cut cleanly and conform to irregular surfaces, such as lap or butt welds, etc., without tearing or breaking.

Another reason for Mono-Block's leadership is its high strength, minimizing loss due to breakage. And the tough, strong surface of Mono-Block can be directly finished with Baldwin-Ehret-Hill No. 1 or Super Powerhouse Cements in many instances without the need for applying wire mesh.

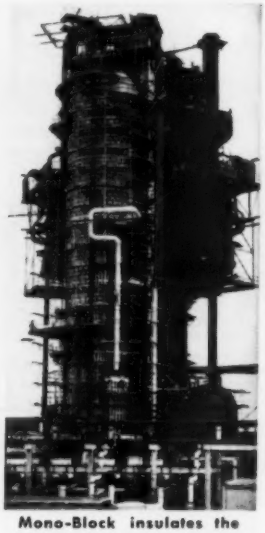
For detailed information about Mono-Block or any of the complete line of industrial insulations manufactured by Baldwin-Ehret-Hill, and the name of your nearby B-E-H qualified contractor, write to Department M-B, Baldwin-Ehret-Hill, Inc., 500 Breunig Ave., Trenton 2, N. J.



B-E-H Mono-Block magnified 10 times to show uniform, interlaced structure resulting from interlocked fibers.



A commercially available block product equally magnified to show the uneven texture.



Mono-Block insulates the world's largest catalytic cracking unit for Tidewater in Delaware.

B E H
BALDWIN-EHRET-HILL

Baldwin-Ehret-Hill manufactures a complete line of mineral fiber, calcium silicate, 85% magnesia and polyurethane industrial insulation products, including pipe insulation, blocks, blankets, felts, cements and loose fill for sub-zero to 1900 F service.

BALDWIN-EHRET-HILL, INC.

Trenton **New Jersey**

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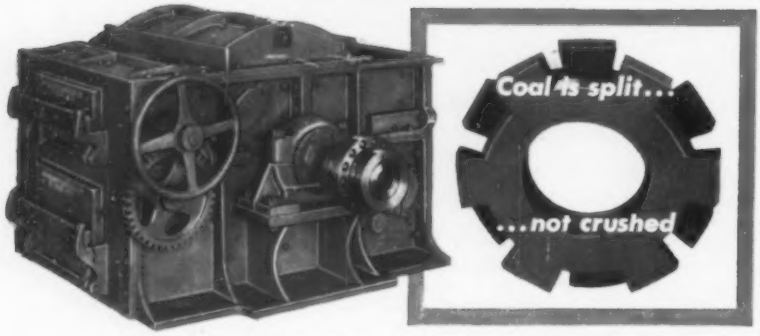
PERFORMANCE-PROVED OVER 50 YEARS



More than a half-century of experience has resulted in consistent improvement in American crushers, yet the rolling ring principle (patented in 1908) still remains the most efficient. Hundreds of "cost of operations" reports from American users prove this fact.

Let American's engineers analyze your requirements. Write for literature; state your tonnage. No obligation.

American PULVERIZER COMPANY
ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS
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The Most Reliable, Long-Lived Cooling Equipment

● Every day this Niagara AIR-COOLED Heat Exchanger is adding $90 revenue while its owner's plant is in operation, from savings in the cost of cooling water.

For more than thirty years similar machines have been making such savings in industries all over the country. They do not wear out, are easy to keep clean and cost little for upkeep. Panel construction makes all parts accessible. Cleanable coils are available.

With the Niagara Aero Heat Exchanger you have a closed system of cooling, free from dirt. Heat is removed at the rate of input, making it easy to control temperatures. The heat is dispersed into the atmosphere by means of evaporation of a very small amount of water, solving the problems of cooling water supply and disposal.

Write for bulletins 120 and 132.

NIAGARA BLOWER COMPANY
Dept. E-6, 405 Lexington Ave., New York 17, N. Y.
Niagara District Engineers in Principal Cities of U.S. and Canada

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vides the most stable and noise free of magnetic flowmeter a-c potentiometers. The entire unit is built on a single removable chassis — amplifiers and preamplifiers and a range network are mounted on plug-in cards. Automatic quadrature rejection requires fewer adjustments while providing high level of stability.

24—Explosion-proof motor for use in hazardous areas

Type VA-EV Varidrive Explosion-Proof Motor, introduced by U.S. Electrical Motors Inc. in ratings from ¼ to 1 hp, offers variable speeds in ratios up to 10:1 for applications in ex-

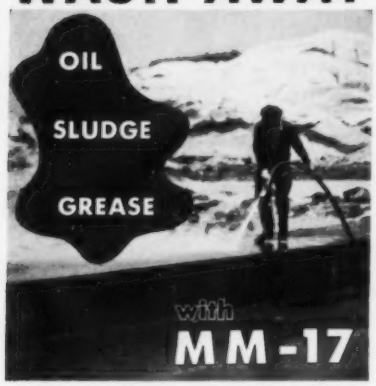
plosive atmospheres of fumes and dust. It is UL approved for service in locations of Class I, Group D, characterized by inflammable gases and volatile liquids, and Class II, Groups E, F and G, combustible dusts. Infinite gradations of variable speeds are obtainable by turning a knob on hand control assembly.

25—Liquid level alarm uses both signal light and bell

When liquid reaches predetermined level, this alarm of King Engineering Corp. turns on a signal light and sounds a horn or bell. A silencer button turns off the sound, but the light stays on until liquid level is changed in desired direction. Alarms are used

with a King-Gage or other air-actuated purge-type gaging system, and can be used with any liquid in any storage or processing vessel that is vented to atmosphere. Models are available for response at high level, low level, or both. High-level and low-level alarms have 110-v signal lights,

WASH AWAY



Sea wall at Scituate, Mass., where heavy deposit of bunker oil from sunken tanker was completely removed by spraying MM-17 on oil and hosing off with water.

- **Quickly and safely emulsifies oil spills**
- **Flushes clean with fresh or salt water**
- **Non-explosive, no toxic vapors, does not burn skin**

MM-17 overcomes emergencies caused by oil spills on land or water. It is the safest and most efficient emulsifier extensively used for this purpose.

MM-17 cuts through deep layers of heavy oil and sludge where ordinary solvents fail. Here is a scientific cleaner for oil tanks, pipe lines, piers, loading platforms and oil handling equipment.

MM-17 is sprayed or brushed on the surface to be cleaned. In minutes, oil and grease can be hosed off or wiped away.

Get ready now for annual clean-up and emergencies. Order MM-17 today and have it on hand when you need it.

Single drums (55 gal.) . . . . . $2.42/gal.
Six drums on same order . . . . $2.18/gal.
Bulk shipment prices on request.

FREE Barrel Drain Truck with first order. Listing for $31.50, this truck is yours free with your first drum of MM-17.

ROCKLAND INDUSTRIES, INC.
CHEMICAL DIVISION
63 Grove Street
Rockland, Massachusetts
TRiangle 8-5340

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while high-and-low-level alarms can be furnished with 110-v or 6-8-v lights. Bulletin EX-700 gives data.

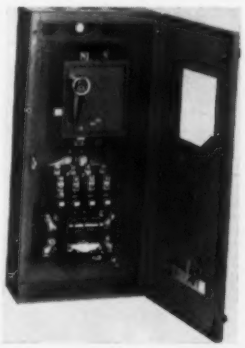
26—Variable speed link belting is adjustable to any length

Variable-speed belting in link form for easy adjustment to required length is available in single (shown) or twin link types, widths from ⅞ to 4 in., from Lovejoy Flexible Coupling Co.

Adjusta-Link fits all V-to-V drives, is interchangeable with endless molded and wood block belts, and sold by the foot. It is heat- and oil-resistant, is installed with pliers and hook tool. Longitudinal flexibility permits easy flexing around small diameter pulleys.

27—Combination motor starters in ultra compact size

Introduced by Federal Pacific Electric Co., these compact combination motor starters combine — in a single enclosure — branch circuit protection and disconnection, and motor starting and running overcurrent protection. Outstanding feature is the rotary handle circuit breakers. Operating handle is integral with breaker mechanism, eliminating mechanical link-



age and providing both positive operation and off-on indication. An additional safety feature is a locking system whereby breaker can be locked on or off independent of door position. Up to three padlocks can be used on the handle.

Compactness has been engineered without sacrifice of wiring space, manufacturer states, and reductions

ILLCO-WAY DESIGNERS AND BUILDERS
MODERN EQUIPMENT FOR **ionXchange**

AT 3 PLANTS OF
DETROIT EDISON

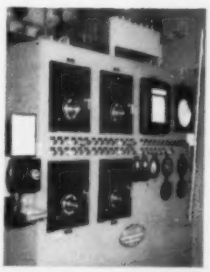
Four IWT installations, the first having been put in 7 years ago, are located in power plants of the Detroit Edison Co., as listed below. The picture at the left shows one of these stations.

RIVER ROUGE POWER PLANT—UNIT NO. 1
Triple Unit Two-Bed De-Ionizers, flow rate 80 gpm *each*, ordered in 1954.

RIVER ROUGE POWER PLANT—UNIT NO. 2
Triple Unit Two-Bed De-Ionizers, flow rate 300 gpm *each*, ordered in 1960.

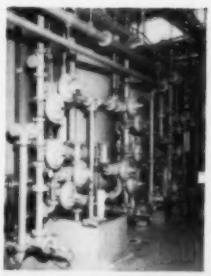
MARYSVILLE POWER PLANT—UNIT NO. 1
Double Unit Two-Bed De-Ionizers, flow rate 170 gpm *each*, ordered in 1957.

DELRAY POWER PLANT—UNIT NO. 2
Double Unit Two-Bed De-Ionizers, flow rate 300 gpm *each*, ordered in 1959.



This picture, taken in the Marysville Power Plant, shows the IWT Control Panel which governs all functions of De-Ionizer regeneration. These control cabinets, which include indicating devices and recording instruments, are designed and built by IWT.

DE-IONIZERS
FOR MAKE-UP WATER



Marysville Power Plant again. This is part of the tanks, piping, power-operated valves, and other elements that are engineered by IWT into a practical, reliable system that delivers high-purity water for high-pressure boiler make-up.

ILLINOIS WATER TREATMENT CO.
840 CEDAR ST., ROCKFORD, ILLINOIS
NEW YORK OFFICE: 141 E. 44th St., New York 17, N.Y.
CANADIAN DIST.: Pumps & Softeners, Ltd., London, Ont.

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up to 50 per cent in wall space achieved. The smallest unit is only 5 in. deep, 8¼ in. wide, 17¾ in. high —can be fitted into the well of a 10-in. I beam. The starters have only one moving part, and operate with a ball-bearing guided moving assembly consisting of movable magnet and contacts. The combination starters come in a variety of units and types, with starters from NEMA O through 3, enclosures NEMA 1 and 12.

28—Low-flow metering pump with totally enclosed drive

The Milroyal, a low-flow, controlled volume metering pump for liquid chemical feed systems featuring enclosed working parts, is introduced by

Milton Roy Co. All working parts of the drive operate in an oil bath. The drive converts the high speed rotary motion of its motor into the reciprocating motion of the pump plunger. The Milroyal can be equipped with leakproof diaphragm liquid end or conventional packed plunger liquid end. It will meter corrosive acids, toxic chemicals, water treating chemicals, others. Capacity adjustments can be made while pump is running—manually or automatically from a control signal. Capacities range from 0.89 gph, for pressures to 4470 psi, to 88.0 gph for pressures to 170 psi. Up to nine pumps can be driven by one motor for special applications.

29—Vinyl plastic wiring duct has rounded top surfaces

Type E Panduct, introduced by Panduit Corp., features rounded top surfaces for protecting wire insulation as well as installer's hands. Deep slots extending near base of duct are separated by individual plastic fingers

which flex enough to allow wire to be inserted into the slots, but snap back after insertion. Wires can be laid after terminals have been attached, with no threading through holes, lacing or bundling. Duct comes

WATER FOR BOILERS NEEDS DEOXY-SOL

- to remove O_2
- reduce oxides
- raise pH

Fairmount DEOXY-SOL, a solution of hydrazine, is a high efficiency oxygen scavenger designed especially for high pressure boiler water treatment.

DEOXY-SOL removes oxygen, reduces oxides and raises pH of the condensate all at the same time . . . yet adds no solids.

Stocks in Newark, N. J., Chicago, Ill., Los Angeles, Calif. Investigate its advantages for your system. Write for Bulletin PE.

Fairmount
CHEMICAL CO., INC.
136 Liberty St., New York 6, N. Y.

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THE LONERGAN LINE

LITTLE THINGS MEAN A LOT

by Norman J. Smith

No, I'm not trying to revive a popular song of a few years ago. Instead, I just want to point out that that statement is true in gauges as well as love.

For example, research has shown that the tip of a Bourdon tube travels not only in a straight line, but, has a definite relationship to the angular length of the active part of the tube and its inactive section, which makes up the tip end.

The arrow shows what I mean by the tip travel.

Why is this important? For several reasons.

First of all, Lonergan gauges utilize all of the movement available from a tube to activate the movement of a gauge. In addition, we arrange the connecting link between tip and movement so as to lie directly in this same true path of motion, thus greatly simplifying calibration. Furthermore, tube life is increased because it is not required to move any farther than necessary to supply the required amount of motion for the pointer on the dial.

I find it impossible not to heed the clamor of the sales department to make a point at this time. That is, a gauge so designed and constructed will last longer, require less maintenance and be easier to recalibrate. All of this means that in the long run, a Lonergan gauge is the most satisfactory one to purchase.

Norman J. Smith

Chief Engineer, Instrument Division

Lonergan

J. E. LONERGAN CO., 207 RACE STREET
PHILADELPHIA 6, PA. SINCE 1872

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BETTER TOOLS FOR BETTER WORK

Whatever your tube maintenance problem— look to WILSON

Wilson has hundreds more to meet every tube maintenance need. Send for comprehensive Catalog 77-88.

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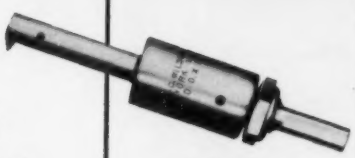
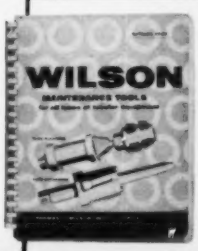
TORQ-AIR-MATIC AUTOMATIC EXPANDER DRIVES



TUBE CUTTER

TUBE EXPANDERS

TUBE PILOT



TUBE CLEANERS

RIGHT ANGLE GEAR DRIVE

THOMAS C. WILSON, INC. 21-11 44TH AVE., LONG ISLAND CITY 1, NEW YORK

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PATENTS PENDING

Spherical

SHOCK TRAP® for WATER LINES

Eliminate water hammer and pipeline bursting.
Save piping and plant costs with guaranteed surge limits.

PULSCO®

Designed primarily for shut-down or shut-off application, this unit is used in pumping plants, irrigation systems, fire control on rocket test stands, municipal water systems, etc. Of the water interface type, the Pulsco swirl principle reduces pressure and reduces shock and surge resulting from kinetic energy within the pipeline, this by compressing gas within the chamber and by friction through the swirl chamber.

Guaranteed not to recycle, this Pulsco Spherical Shock Trap is built for pressures to 200 PSIG and up. Sizes from 34 to 102 inches diam.

PULSCO *Bellows* SHOCK TRAP

For AIRCRAFT AND MARINE FUEL LOADING SYSTEMS JET FUEL AND GASOLINE

PAT. PEND.

Take the "hammer" out of high velocity fuel lines — removes the danger of broken lines, meters, and overstressed loading equipment. Assure correct meter readings consistently with this Pulsco scientifically designed Bellows Shock Trap — the best for quick STOP and GO liquid lines.

SEND FOR BULLETINS AND APPLICATION DATA SHEET
Representatives in all principal cities

PULSATION CONTROLS CORPORATION
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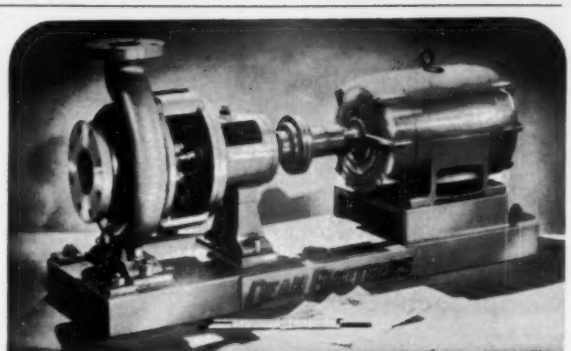

FOR EASE IN SOLVING CORROSION PROBLEMS CHECK THE 4 E's OF DEAN BROTHERS TYPE pH PUMPS

✓ **Easy to Select**—28 sizes (14 horizontal, 14 vertical) available in 14 corrosion-resistant alloys, to fit your special pumping problem.

✓ **Economical to Buy**—Low first cost combined with easy servicing and maximum interchangeability of parts make pH pumps lowest cost in the long run.

✓ **Easy to Install**—Centerline suction and discharge connections. No need to remove from suction or discharge piping for servicing.

✓ **Economical to Operate**—Fully open impellers for slurries and clear liquids contribute to long, trouble-free service life with minimum down-time.

For Complete Information Write for Circular 217

DEAN BROTHERS PUMPS INC.
INDIANAPOLIS 7, INDIANA

The Best Is Our Standard

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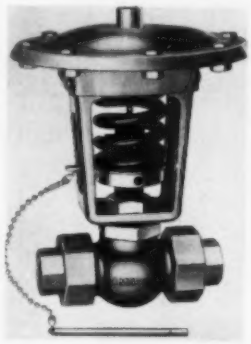
in 5- or 6-ft. lengths in white, black, dark or light gray; it can be cut with hand or power saw. Modular corner, tee, transition and straight-through fittings are available.

30—Safety case gage provides viewer protection

Maximum protection from possible explosive forces resulting from accidental over pressuring of the Bourdon tube is provided by an integrally cast solid wall in J. E. Lonergan Co.'s Safe-T-Kase Gauge. Wall separates bourdon tube assembly from the ring, glass and dial. Glass itself is safety type, and entire back of case is covered by a spring mounted pressure-releasing plate. Less than ½ psi pressure will force plate open, and in event of rupture, the pressure medium is discharged out of the back of the case, away from operating personnel. It is available in two case styles, 4½-, 6- and 8½-in. sizes.

31—Pressure regulators are direct or reverse acting

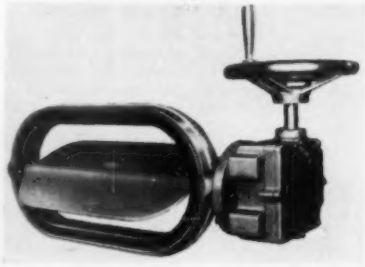
Featuring a packless valve that permits immediate response to slightest pressure change, these regulators are for use with steam, air, water and gases that are non-corrosive to bronze, iron or Neoprene. They are available



from Manning, Maxwell & Moore, Inc. in both direct and reverse-acting types, in single- and double-seated designs, sizes from ½ through 2 in. Double seated and larger single-seated valves can be reversed in the field. Valve body is bronze heavy section type for rated pressures to 250 psig. Diaphragms are flexible Neoprene impregnated nylon. Stainless steel upper diaphragm housing is lipped over to protect outer edge of diaphragm. Bulletin 116 gives information.

32—Butterfly valves designed for ventilating, air conditioning

Obround Series K Valves are control and shutoff butterfly valves developed by W. S. Rockwell Co. for rectangular and flat oval ducts for industrial and process ventilation and air conditioning. The valve has a one-piece aluminum alloy body of small face-to-face dimension so that it is light and compact; it is adaptable with simple transitional fittings. The body has a Keelok replaceable rubber or synthetic resilient elastomer liner, against which the oval aluminum disc seats. Throttling and shutoff can be controlled by lever, handwheel (as shown) or automatically by pneumatic cylinder, diaphragm operator or electric motor. A dial indicates disc position. For automatic control, a valve positioner may be included. Fourteen sizes range from 3-by-7 to 20-by-30 in.

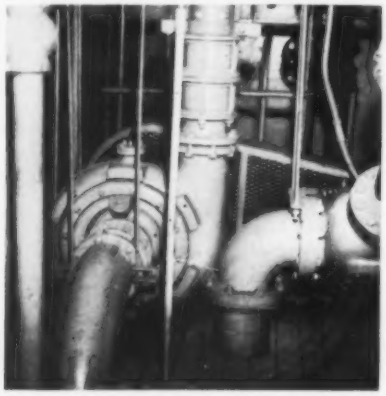


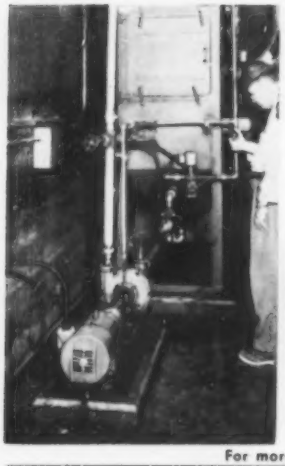
YOU CAN HANDLE

- FLY ASH
- WETTED COAL DUST
- GRITTY DRAINAGE

economically with

Nagle Pumps





They are designed specifically to pump highly abrasive solutions or slurries. Nagle "K" series pumps are shown—one of two 6" type "KR" pumps handling fly ash from wet bottom combustion chambers at Town of Hempstead, N.Y. Dept. of Sanitation and a 1" type "KC" pumping coal dust in water in basement of breaker structure at Gallatin Steam Plant of the T.V.A.

Tough jobs call for

Nagle PUMPS

FOR ABUSIVE APPLICATIONS EXCLUSIVELY

They feature simple, readily accessible stuffing box adjustment and easy slippage seal adjustment. Built for years of gruelling service.

Many power generating companies and others employing boilers, incinerators or furnaces, have had excellent performance from Nagle Ash Handling Pumps—both horizontal shaft and vertical shaft type. Send for Nagle Pump Selector. Nagle Pumps, Inc., 1229 Center Avenue, Chicago Heights, Ill.

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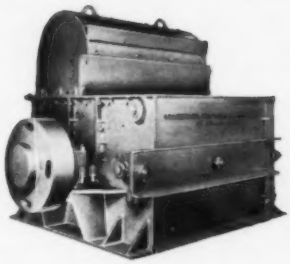
Major chemical processing company is seeking a Bachelor's graduate in mechanical engineering with eight to ten years' recent experience in power plant design including steam and power generation and water treatment.

Assignment involves complete design of power facilities including equipment layout, mechanical and piping design and layout, and coordination of related structural, architectural, concrete, electrical and instrument design. Ability to develop basic data (utility flow sheets and piping and process control diagrams), prepare equipment specifications for steam and power generating equipment and accessories and size and select such equipment required.

Submit resume of academic training, experience and salary in confidence to Box 1741, POWER ENGINEERING, 308 East James St., Barrington, Illinois.

This GRUENDLER CRUSHER handles

600 TONS OF COAL PER HOUR WITH EASE!



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Lower original cost
Lower maintenance
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GRUENDLER CRUSHERS ARE BEST

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33 — Plastic end fittings for underground power line pipe

Belled-end fittings that facilitate inserting power cables at the start of underground conduits of thermoplastic pipe are announced by Tube Turns Plastics Inc. Fittings are fabricated from stock sizes of polypropylene, polyethylene, polyvinyl chloride or other thermoplastic piping. The bell-

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DESIGNED FOR STEAM TURBINE TESTING

TYPE WG DEAD WEIGHT PRESSURE GAGE

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★ EXTREMELY HIGH NEGATIVE PRESSURES
★ ACID RESISTING FINISHES
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Canadian 593,817
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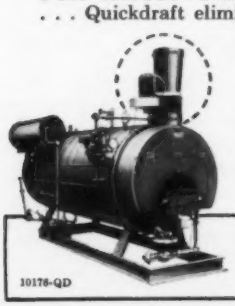

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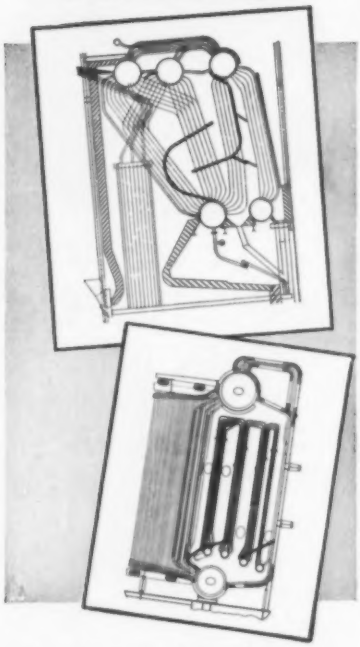

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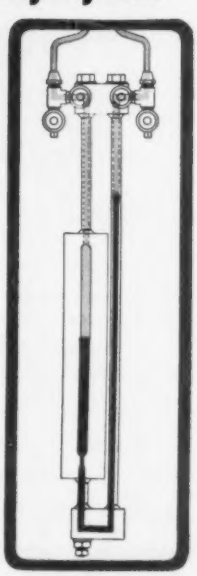
This green liquid column could be your boiler water level –

a true check on your boiler's safety by the

Reliance EYE-HYE



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Easy to install, easy to maintain. With no mechanical working parts to fail – no gears, magnets, diaphragms or linkage – it's simple, fool-proof. No adjustments. Each EYE-HYE is factory-calibrated to *your* water level range and working steam pressure.

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The Reliance Gauge Column Co. • 5902 Carnegie Ave., Cleveland 3, Ohio

Reliance® BOILER SAFETY DEVICES

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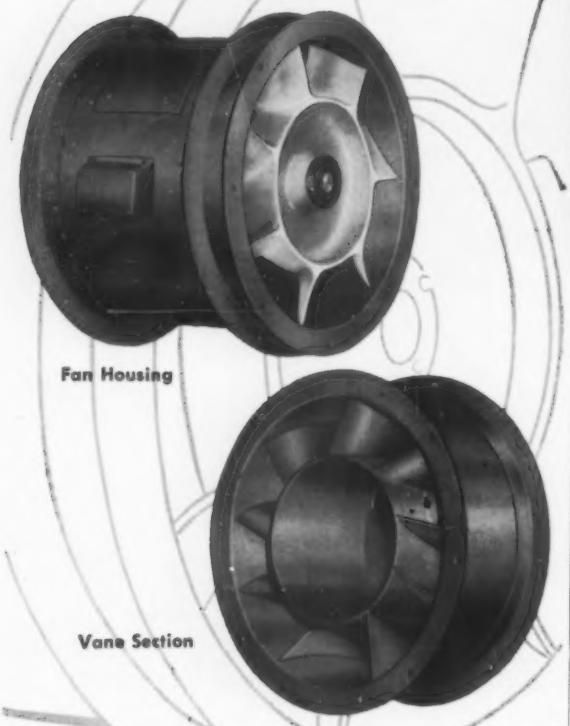
another outstanding design development from

Aerovent



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with removable vane sections

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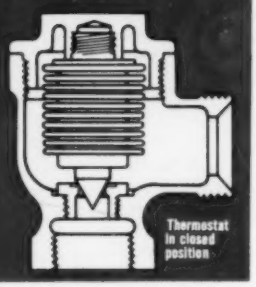
Sterlco®
STEAM TRAPS

"FAIL-SAFE" VACUUM THERMOSTAT CLOSES TRAP IF DAMAGE OCCURS



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2 Efficient operation regardless of pressure changes . . . vacuum thermostat compensates for pressure changes.

3 Small overall dimension assures easy replacement of your present traps.

4 "Fail-Safe" vacuum thermostat used in all Sterlco Radiator and F & T Traps.

For complete information on Sterlco Radiator and Float & Thermostatic Traps, write for Bulletin 102.

Condensation Pumps, Steam Traps, Heating Specialties

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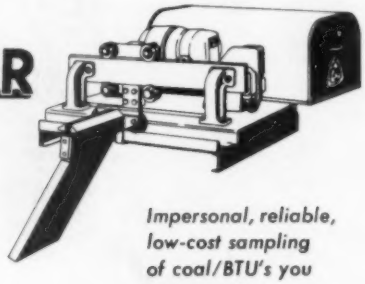
DENVER



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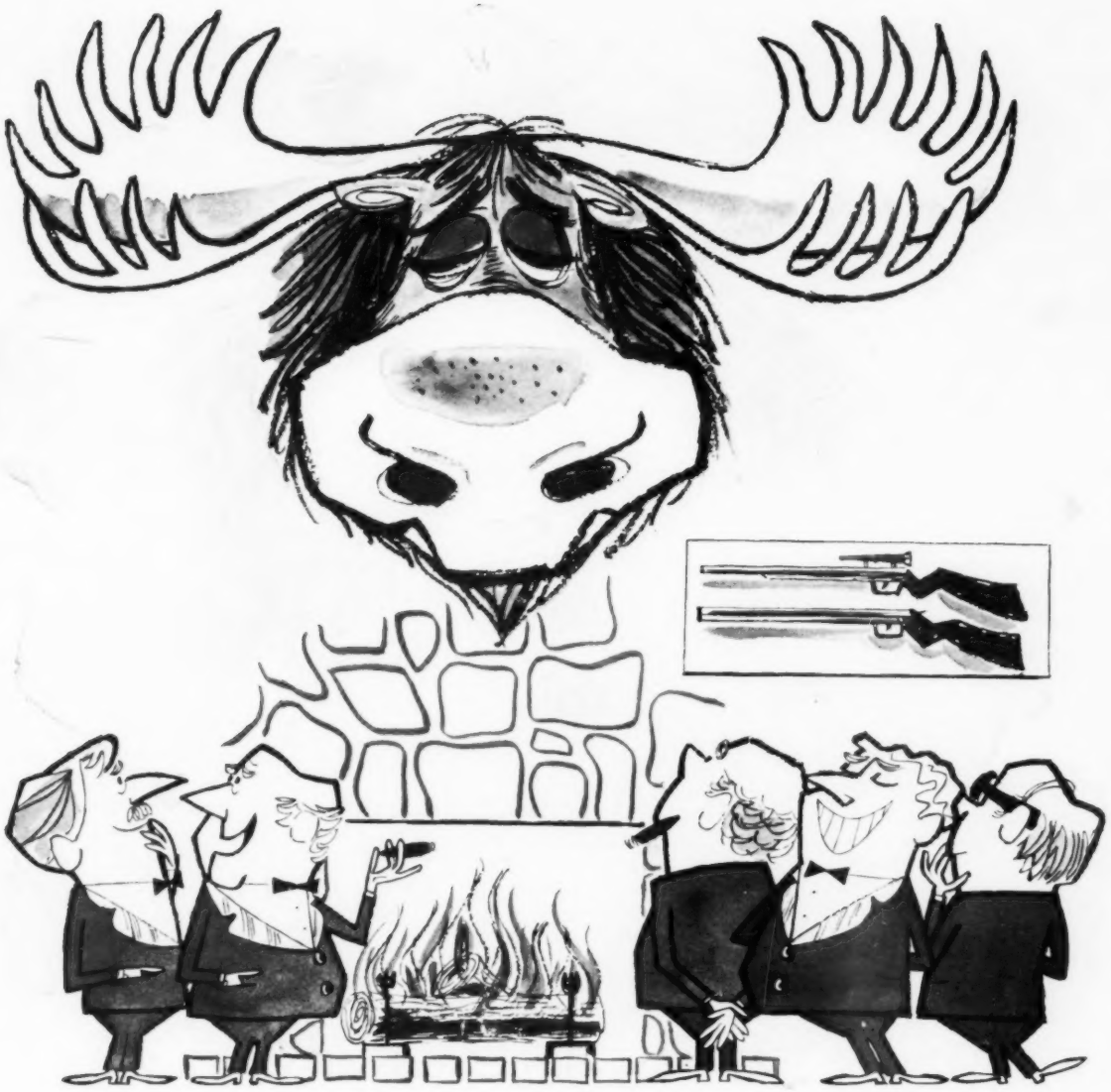

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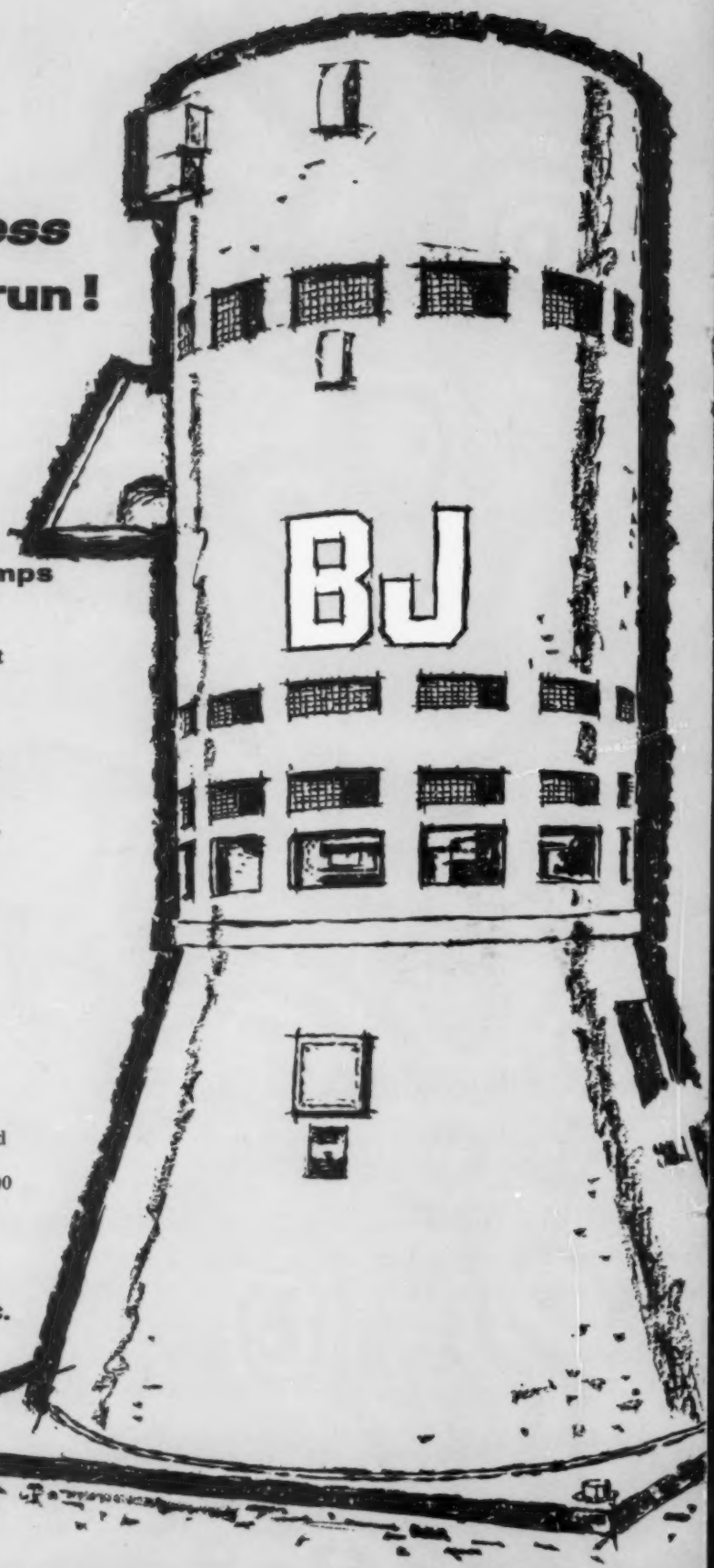

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